ECOLOGICAL SURVEY OF THE PROPOSED CLARK FORK RESEARCH NATURAL AREA STANISLAUS NATIONAL FOREST, TUOLUMNE COUNTY, CALIFORNIA

TODD KEELER-WOLF

APRIL 1991

(PURCHASE ORDER # 40-9AD6-9-0407)

INTRODUCTION

The Clark Fork candidate Research Natural Area (CFRNA) is on the Summit Ranger District of the Stanislaus National Forest. The area was selected and nominated by the Forest in 1981 to represent the white fir (*Abies concolor*)[1] target element for the Northern Sierra Nevada Province.

As originally defined the CFRNA covered 609 acres (246.5 ha). However, based on ecological assessment of the area, the site as described in this report has been enlarged to encompass 2160 acres (874.1 ha) (see maps 1, 2, and 3). The boundary considered herein includes all or portions of sects. 33 and 34 T7N, R20E, and sects. 3, 4, 5, 8, 9, 10, 15, 16, and 17 T6N, R 20E MDM. The approximate center of the proposed RNA is 38° 23' N by 119° 48' W. The area is shown on USGS 7.5 minute quadrangles Dardanelle (quad number 490-4C) and Dardanelles Cone (490-1C).

Overall topographic relief is substantial, ranging from about 6000 ft. (1829 m) along the Clark Fork in the nw portion of the area to 9836 ft. (2998.0 m) atop the highest peak in the sw 1/4 sect. 10. This represents an elevational range of 3836 ft. (1169.2 m).

Access:

The CFRNA is easily accessible from the north via the Clark Fork Road (Forest Road 7N83). Part of the lowest elevations in the RNA are adjacent to the Clark Fork Campground concession. Following is a travel log describing access from the Summit Ranger Station, Stanislaus National Forest:

From the Summit Ranger Station along State Highway 108 (Sonora Pass Highway) travel east on 108 for approximately 22 miles (35 km) to the junction with the Clark Fork Rd. (7N83). Turn north, crossing the Stanislaus River, continue northeast approximately 5 miles (8 km) to the turnoff for the Clark Fork Campground (Road 7N76). Access to the low elevation nw side of the RNA can be had from the campground (see map 2) or from the gated road 7N76A which skirts the east side of the campground and terminates at two small water tanks (shown incorrectly on the topo map, these are actually on the north side of the stream in the SW 1/4 sect. 5).

---

[1] all scientific names for plants are in accordance with Munz (1968)

Access to the northeastern portion of the RNA can be gained via road 6N16 (to the Clark Fork Horse Camp), which branches off 7N76 just before reaching the campground. The lower portions of the area, including the majority of the white fir target, are easily accessible. Slopes are gentle-to- moderate between 6000 and 6400 ft. (1829-1951 m) throughout the area. However, the upper elevations are steep and relatively inaccessible. The most direct access routes to the summit area are at the northeast corner of the area. By following any of several ridgelines, one may walk from the lower elevations to 9200 ft. (2804 m) and above in about 2 hours.

At the mid-elevations, slopes are generally steep and rocky with understory cover preventing easy travel in drainageways and on mountain chaparral-dominated sites. The upper elevations (> 9000 ft., 2743 m) are usually open with relatively gentle or moderate slopes. The steepest and most inaccessible parts of the area are the escarpments which tend to form on north aspects of volcanic rock at the upper elevations.

PRINCIPAL DISTINGUISHING FEATURES

The CFRNA has been nominated to represent the white fir target element for the northern Sierra Nevada Province. Stands of white fir at CFRNA vary and include even-aged young and dense groves dating back to fires ca. 80 years ago, mature mesic and rocky north slope stands, and highly productive mature bottomland stands on alluvium. The entire range of white fir dominance is present with transitional forests to mixed conifer at the lower elevations on xeric sites and red fir (*Abies magnifica*)-white fir transition forests at the mid-elevations.

In addition to the white fir target, the area contains good examples of red fir forest ranging throughout its entire local elevational distribution. Patches of mountain hemlock (*Tsuga mertensiana*), lodgepole pine (*Pinus contorta* ssp. *murrayana*), and whitebark pine (*P. albicaulis*) occur in the subalpine zone, along with large areas of subalpine dry meadow, scree and talus communities.

The hydric associations are well represented in the area, ranging from wet to dry subalpine and montane meadows, and including mountain alder (*Alnus tenuifolia*) riparian thickets, and patches of black cottonwood (*Populus trichocarpa*) and aspen (*P. tremuloides*) along the lower elevation creeks.

Substrate varies from granitic at most of the mid- and lower elevations to extensive volcanic latites at the higher elevations.

JUSTIFICATIONS FOR ESTABLISHMENT AND BACKGROUND INFORMATION ON TARGET ELEMENT

White Fir:

White fir-dominated forest is widespread in California, ranging from the disjunct desert stands on high mountains of the eastern Mojave, through the relatively open fir forests of the southern California mountains. It is most extensive in the Sierra Nevada and the Klamath Mountain Province, where it usually forms a narrow belt between the mixed conifer forest and the red fir forest. In the Sierra, Barbour (1988) views the California white fir forest as a distinct phase of the Sierran mid-montane coniferous forest. Some other California ecologists view it as a distinct forest type (e.g., Thorne 1976, Rundel et al. 1977, Matayas and Parker 1978). In the Klamath Province it is considered the regional dominant of mid-elevation montane forests (Sawyer and Thornburgh 1977).

The role of white fir in the southern California mountains (e.g., Borchert and Hibberd 1984) is one of a mesophile, preferring the northerly-facing, sheltered aspects at all but the highest elevations within its zone of tolerance. In the Sierra Nevada its mesophilic role is ameliorated to some degree by relatively higher precipitation than in southern California, but it is still the most mesophilic dominant in the mid-montane Sierran mixed conifer forests (Barbour 1988). This relationship holds true even north into the Cascade Range of Oregon where white fir and Douglas-fir (*Pseudotsuga menziesii*) are the two principal climax species of the mixed conifer forest belt, with white fir typifying the modal and moist sites (Franklin 1988).

In the Sierra Nevada white fir dominance is often associated with disturbance (Gordon 1980, Holland 1986). White fir dominates thousands of acres of land that were logged and burned in the last century. Areas that were disturbed by placer mining in the mid-1800's also are commonly dominated by white fir.

Despite the disturbance factor, white fir is considered to be the most shade-tolerant of the five major coniferous species of the mid-montane coniferous forests in California (Rundel et al. 1977). It usually dominates

the reproduction layers of mixed conifer forest spared from ground fires for relatively long periods. This tolerance means that dense stands of saplings commonly occur in the shade of other forest canopy species as well as in the shade of successional mountain chaparral thickets.

With a relatively long interval between disturbances, monospecific dominance is the rule in the heart of the white fir zone. This dominance is fostered by shade-tolerance (saplings may survive suppression for many years) and competitive superiority (rapid growth rates in response to increased light) of the species (Laacke and Fiske 1983).

The touching crowns of the dominant white fir trees, tendency to retain lower branches, dense clumps of reproduction, and high duff accumulation all foster crown fire. Crown fire is the typical form of fire in white fir forest, and promotes the widespread even-aged structure and monospecific stands (Conard and Radosevich 1982).

Although fire frequency (represented by low intensity ground fires) is thought to be naturally high (<1 per 16 years) in mixed conifer forest of California, upper elevation coniferous forests appear to have a lower frequency (Barbour 1988, Conard and Radosevich 1982). The position of the white fir forest zone, at the interface between upper montane and lower montane vegetation suggests an irregular fire cycle where years may go by without an extensive fire, followed by years with a more closely spaced series of fires. Such a cycle allows sufficient time for development of white fir canopy and the demise of less shade-tolerant trees, followed by destruction of the canopy, successional dominance by montane chaparral (prolonged during shorter fire cycles and on xeric, rocky sites), and recolonization and dominance by white fir (with another long fire interval).

According to Tonnesen (1981) selecting a white fir RNA site is difficult for the northern Sierra Nevada, as the target is not as widespread as red fir forest and other mid-montane coniferous forests, and frequency of human disturbance is high within the white fir zone. However, several other candidate or established RNAs contain examples of white fir forest in the province. These include Babbitt Peak, Mt. Pleasant, Mud Lake, and Sugar Pine Point (Keeler-Wolf 1990).

The best developed of these other sites for the white fir target is Babbitt

Pk. (Talley 1977a). At Babbitt Peak white fir dominates on 425 acres (172 ha). Babbitt Peak lies on the eastern margin of the Northern Sierra province only a few miles from the edge of the Great Basin. Annual average temperatures are probably somewhat colder and precipitation is substantially less than at the CFRNA. White fir forest varies from nearly pure stands of ca. 100 year old trees to more mature forest with white fir and western white pine (*Pinus monticola*). There is a gradient from forests strongly dominated by white fir at the lower elevations to a broad mixing zone where western white pine and white fir co-dominate, and finally to western white pine dominated stands at the upper elevations. Jeffrey pine (*Pinus jeffreyi*) is also a significant component on some s. and w-facing slopes. Red fir is restricted to concave n-facing slopes.

Compared to Babbitt Peak, Clark Fork has a wider range of white fir dominance types. These include low elevation alluvial stands dominated by large white fir, and mixed conifer stands where white fir is the highest density species, but Jeffrey pine, sugar pine (*Pinus lambertiana*) and incense-cedar (*Calocedrus decurrens*) co-dominate with white fir in the canopy. Both of these types are absent from Babbitt Peak. Also absent are the extensive transitional forests with red fir. At Clark Fork, these ecotonal forests form a broad mixing zone between about 7000 and 7800 ft. (2134-2377 m), depending on slope exposure. Shared between Babbitt Peak and CFRNA are extensive young stands of white fir resulting from crown fire occurring around the turn of the century.

The lack of other mixed conifer forest species such as incense-cedar and sugar pine, and the transitional white fir forests to western white pine instead of to red fir suggests the relatively dry-interior site conditions at Babbitt Peak compared to Clark Fork. The substrate at Babbitt Peak is entirely volcanic, while virtually all the white fir forest at Clark Fork is underlain by granitic rock.

Another former candidate RNA (later dropped because it lies within an Experimental Forest), Onion Creek (Talley 1977b), is in a similar environment to the CFRNA and contains about 250 acres (101 ha) of white fir forest. This area on the western slope of the northern Sierra has exhibited a steady upsurge of white fir in the past 300 years. Dry meadows, incense-cedar groves, red fir forest, and mixed conifer forest have all shown marked increases in white fir establishment over the past several

hundred years. This increase correlates with increasing warmth, augmented by above average precipitation in the past 100+ years. Reduction of fire frequencies may also explain the recent white fir invasion at elevations below 6562 ft. (2000 m).

Onion Creek is about 65 miles (105 km) n of CFRNA. The elevational range of white fir dominance is smaller than at CFRNA. Both areas have low elevations of ca. 6000 ft. (1829 m). However, this is near the low extreme of white fir dominance in the Clark Fork area, but well within the zone of white fir dominance at Onion Creek. Red fir at Onion Creek begins to strongly dominate at elevations above 6890 ft. (2100 m), while at CFRNA it does not strongly dominate below ca. 7200 ft. (2195 m) even on north slopes. This suggests that a shift northward of 65 miles (105 km) translates into an elevational shift downward of ca. 300 ft. (91 m) in the zone of white fir dominance.

The diversity of slope aspect and elevational range of the white fir forests at CFRNA will provide valuable comparative data on growth rates and will insure coverage of this forest type even in the event of long-term environmental effects such as climatic change.

Rare Plants:

Cryptantha crymophila, a member of the California Native Plant Society's list 4 (Smith and Berg 1988) occurs on volcanic soils of the upper elevations in scree and open rocky meadows. This taxon is endemic to the mountains of Tuolumne and Alpine Counties.

Animals of Special Concern:

At least five species of special concern (Steinhart 1990) occur in the CFRNA. All species are raptors and at least two are apparent breeders in or adjacent to the RNA. The spotted owl (*Strix occidentalis*) is known to have reared a brood in the RNA in 1989. Of 36 pairs studied by Stanislaus N.F. wildlife biologists in the 1989 breeding season, the Clark Fork pair was one of only two that successfully fledged young (Tom Beck Stanislaus N.F. S.O. pers. comm. 1989).

Goshawks (*Accipiter gentilis*) were seen daily during the ecological survey. At least three individuals; a male, a female, and a juvenile were seen regularly at the lower elevations between the northwest and the northeast corners of the RNA. The juvenile was closely associated with the adults and

appeared to have been recently fledged. Although no nest was seen, the regular presence of the family group in the area suggests that nesting did occur in or adjacent to the RNA.

The other species of special concern are Cooper's Hawk (*Accipiter cooperi*) sharp-shinned hawk (*Accipiter striatus*), and golden eagle (*Aquila chrysaetos*). All three of these species were sighted individually on one day in the area and are possible local breeders.

Substrate Diversity:

The majority of the lower elevations of the CFRNA are underlain by a portion of the Sierra Nevada Batholith, the huge intrusion of granitic rock which composes the core of the High Sierra. However, above ca. 8500 ft. (2591 m) the volcanic rocks of the Stanislaus Formation dominate and form a cap over 1000 feet (305 m) thick rising to the highest points of the RNA. The vegetation differences between the granitic and the volcanic soils are pronounced. The volcanics support denser red fir forest than the granitics, and an extensive dry meadow community not present on granitic soils. Several species appear to be restricted to the volcanic soils (see vegetation section for details).

Elevational Range and Ecological Integrity:

As presently defined, the CFRNA supports vegetation ranging from white fir and upper montane mixed conifer forest to subalpine forests of mountain hemlock (*Tsuga mertensiana*), whitebark pine (*Pinus albicaulis*), and lodgepole pine (*Pinus contorta* var. *murrayana*). Between these extremes are extensive red fir forests; montane chaparral; talus, scree, and rock outcrop communities; riparian thickets; and wet and dry montane and subalpine meadows. The drainages of four low order tributaries to the Clark Fork of the Stanislaus River are all or partially included within the RNA. The surrounding watersheds are in a wilderness planning area, likely to be included within the Carson-Iceberg Wilderness Area (Tom Beck, Stanislaus N.F. S.O., pers. comm. 1989). Thus, ecological diversity and integrity is high within the proposed RNA. Its values beyond that of a white fir study are substantial, and are strongly associated with its extension to the crests of the mountains within an area of low human impact.

PHYSICAL AND CLIMATIC CONDITIONS

The CFRNA occupies a portion of the north slopes of the Bald Peak - Red Peak divide, separating the Clark Fork Drainage on the north from the upper Middle Fork of the Stanislaus River Drainage to the south. All drainages in the CFRNA empty into the westward-flowing Clark Fork. This area is part of the central Sierra Nevada lying about 6 miles (10 km) west of the Sierra Crest at Stanislaus Peak. Based on the physiographic provinces defined for the Region 5 RNA program, the CFRNA occurs in the extreme southern end of the northern Sierra Nevada Province. The principal criterion used to delineate the northern and southern Sierra provinces (D. Diaz, Regional Ecologist, pers. comm. 1989) was the marked increase of Cenozoic volcanic rock north of Highway 108 (Sonora Pass Road), with a concomitant decrease in the extent of granitic rock, typical of the southern Sierra Nevada. At CFRNA, both rock types occur, with the volcanics restricted to the upper elevations (see map 5). The type locality of the Stanislaus Formation, an extensive volcanic latite series in the central Sierra, is the Bald Peak-Red Peak divide (Slemmons 1966). At Bald Peak the thickness of this formation is over 1000 ft. (305 m). The Stanislaus Formation includes latite intrusives, welded quartz latite tuff, and latite flows, all of which occur in the RNA.

The majority of the CFRNA is underlain by Mesozoic granitics of the Sierra Nevada Batholith. The volcanics rest atop the granitics. There appears to be little metamorphism or transition between the two principal rock types. Both types may exhibit steep topography, but the volcanics are frequently more spectacular, with glacially carved cirque headwalls and strangely eroded badlands (photo 1).

The substantial and abrupt elevational changes within the CFRNA bring about corresponding changes in precipitation and temperature in the area. Although no temperature or precipitation recording stations occur in or adjacent to the proposed RNA, reasonable estimates can be made using information from Goodridge (1981), Rantz (1972), and State Department of Water Resources (1988).

The nearest station recording year-round temperature and precipitation is the Summit Ranger Station near Pinecrest. This site is at an approximate elevation of 5700 ft (1737 m) and is approximately 18 miles (29 km) southwest of the CFRNA. Records are kept at the Dispatch Office in the

Stanislaus National Forest Supervisor's Office, Sonora California. These records are not in any summarized form and are thus, not summarized here. The nearest stations with summarized weather data are Calaveras Big Trees State Park approximately 29 miles (47 km) WSW of CFRNA (Latitude 38° 17' N, Longitude 120° 19' W) at an elevation of 4696 ft. (1431 m) and Cherry Valley Dam approximately 29 miles (47 km) SSW of CFRNA (Latitude 37° 38' N, Longitude 119° 35' W) at an elevation of 4765 ft. (1452 m). Calaveras Big Trees has been recording data for 50 years and the Cherry Valley Dam station has been operating for 35 years. Both of these stations are approximately 2000 ft. (607 m) lower in elevation than the core of the white fir zone at CFRNA and hence, probably are substantially warmer and receive somewhat less total precipitation than CFRNA. The following tables summarize temperature and precipitation data for both sites for a 12 year period from 1974 through 1985.

Table 1: Temperature data (°F) from Calaveras Big Trees 1974-1985.

year	$\bar{x}$ ann. temp	highest temp. (w/date)	lowest temp. (w/ date)	last spr. frost	first fall frost	# days between 1st & last frost
'74	49.6	90 (8/3)	10 (1/2)	5/21	10/29	161
'75	48.6	96 (7/27)	14 (11/30)	6/25	10/7	104
'76	-	94 (6/28)	13 (3/4)	5/28	10/29	139
'77	51.1	97 (6/26)	15 (11/20)	5/24	10/31	160
'78	49.6	97 (8/9)	12 (12/8)	5/26	9/18	115
'79	49.1	95 (7/18)	7 (1/29)	5/10	10/21	164
'80	49.6	95 (7/26)	19 (1/30)	5/8	10/20	140
'81	51.0	98 (8/9)	16 (1/31)	6/13	10/21	121
'82	47.5	92 (8/1)	11 (1/22)	5/18	9/30	135
'83	48.6	92 (8/7)	18 (1/20)	5/11	11/8	181
'84	49.9	93 (7/5)	13 (12/17)	5/16	10/15	152
'85	49.2	91 (6/17)	8 (2/5)	6/1	10/9	130
means	49.4	94	13			142

Table 2: Temperature data (°F) from Cherry Valley Dam 1974-1985.

year	$\bar{x}$ ann. temp.	highest temp. (w/date)	lowest temp. (w/date)	last spr. frost	first fall frost	# days between 1st & last frost
'74	53.3	94 (8/1)	10 (1/2)	5/20	10/29	162
'75	51.9	99 (7/27)	12 (11/29)	5/21	10/7	139
'76	-	96 (8/31)	14 (3/4)	4/28	11/13	199
'77	-	100 (8/1)	14 (3/13)	3/29	11/14	218
'78	-	99 (8/6)	14 (12/7)	5/25	10/30	158
'79	52.4	98 (7/18)	9 (1/28)	5/8	10/20	165
'80	53.1	98 (7/28)	18 (12/7)	-	10/15	-
'81	54.2	103 (8/9)	9 (1/31)	5/20	10/12	145
'82	50.5	95 (7/30)	12 (1/3)	5/10	10/26	169
'83	51.0	96 (8/6)	15 (1/20)	5/9	11/7	182
'84	53.1	97 (7/4)	13 (12/17)	4/21	10/14	170
'85	52.9	94 (6/18)	11 (12/9)	5/10	10/20	163
means	52.4	97.4	12.5			170

Table 3: Precipitation data (in inches) for Calaveras Big Trees and Cherry Valley Dam 1974-1985.

	Calaveras Big Trees			Cherry Valley Dam		
yr.	Jan. total	July total	Annual	Jan. total	July total	Annual
'74	8.81	3.54	52.38	7.07	1.26	38.01
'75	5.85	0.14	58.97	4.23	0.40	49.55
'76	0.47	0.08	22.06	0.45	0.19	18.78
'77	4.25	0.16	35.10	3.22	0.00	-
'78	18.97	t	71.40	-	-	-
'79	13.12	0.33	61.30	10.34	0.07	45.21
'80	24.63	0.30	60.68	22.62	0.68	55.54
'81	14.32	0.09	66.74	9.73	0.04	52.53
'82	15.70	0.07	100.35	15.55	0.00	89.84
'83	13.33	0.00	109.12	11.96	0.00	95.48
'84	0.50	t	38.41	0.30	0.06	33.26
'85	2.15	0.33	41.57	1.15	0.20	38.79
means	10.18	0.56	59.84	7.87	0.36	51.70

As can be seen from the previous tables, although the Cherry Valley site is somewhat higher in elevation than Calaveras Big Trees, it averages lower precipitation and higher temperatures. These points probably indicate the influence of topography and exposure, with the Calaveras site occupying a valley bottom surrounded by dense forest while the Cherry Valley site is on a southerly exposure in a relatively open canyon. CFRNA probably receives an average annual precipitation between 50 and 60 inches (1270-1524 mm). This figure is based on isohyets in Rantz (1972). Temperatures at CFRNA may be extrapolated from Calaveras Big Trees and Cherry Valley Dam. Assuming a lapse rate of 3°F for every 1000 ft. elevation (1.67°C/305 m) the mean annual temperature at 6600 ft. (2011.7 m) at CFRNA is approximately 44-46°F (6.7-7.8 °C).

A snow course operated by Pacific Gas and Electric has been sampled since 1930 at Niagra Flat at ca. 6500 ft. (1981 m) elevation, and 8 miles (12.8 km) SW of the CFRNA. The average April 1 water content of this sample area is 21.5 inches (546 mm) (State Department of Water Resources 1988). Another snow course operated by Pacific Gas and Electric at Clark Fork Meadow ca. 5 miles (8 km) ESE of Bald Peak at 8900 ft. (2712 m) has an average April 1 water content of 41.8 inches (1061.7 mm). The former site is representative of the snow pack at lower elevations of CFRNA while the latter site is representative of the snow accumulation at sheltered sites in the upper elevations of the study area.

Snow loads on steep slopes at the upper elevations commonly reach "critical mass" and avalanches are regular (estimated at ca. one per 10 years). Most ravines and drainageways show evidence of recent avalanche scouring (photo 2) and the dis-climax montane chaparral and alder thicket vegetation in these areas is maintained by these regular events.

During the visit for the ecological survey (August 21-24, 1989) weather was unseasonably cool with brisk southerly winds occurring much of the time. Cumulus clouds were common but did not develop into thunderheads in the afternoon. Low temperatures at 6200 ft. (1890 m) ranged between. 31-49°F (-0.5 and 9.4° C) and highs were between 64 and 70° F (17.8-21.1° C) during this period.

VEGETATION AND FLORA

Approximately 230 species of higher plants were identified from the CFRNA

during the four day visit to the area. The highest diversity of species is associated with the moist riparian and meadow habitats. The single rare species *Cryptantha crymophila* , is associated with the high elevation volcanic subalpine/alpine dry meadows and scree.

Vegetation Types:

The vegetation map (map 4) is organized based on the system of Holland (1986). Following is a description of the major plant associations occurring in the CFRNA. Table 4 presents the acreages and percent cover of the vegetation types. The code numbers indicate the Holland (1986) community equivalents. Vegetation types are arranged in order from largest to smallest area covered.

White Fir (84240):

The target element occurs in a diverse array of cover types within the CFRNA. Sampling was conducted in four of the five major sub-types or phases. In each sampled sub-type ten 10 x 10 m plots were laid out along a transect at 75 m intervals.

Alluvial Phase: The first transect (tables 5 and 6) is located in the alluvial phase, situated along the valley floor of the Clark Fork. It is characterized by a productive forest strongly dominated by white fir, but with scattered old Jeffrey pine at a density of about 40/ha (photo 3). The density of fallen trunks and snags of large Jeffrey pine in the alluvial forest suggests that Jeffrey pines have lost dominance relatively recently (over the last 50-100 years). It is probable that this forest was co-dominated by Jeffrey pine and white fir about 200 years ago.

Site conditions of this alluvial forest include relatively deep alluvial soil (Gerle Family deep soils, either alluvial or glacial till) with widely scattered boulders, level-to-gently sloping terrain averaging 0-8° slope, and mesic soil moisture conditions. The canopy is dominated by white fir averaging 140 ft. (42.7 m) tall and 2.5-3 ft. (76-91 cm) dbh. Occasional dominants are up to 4 ft. (1.2 m) dbh and 160 ft. (48.8 m) tall. These large white fir may not be exceptionally old (a tree 4 ft. in diameter at 30" above the base was aged at 165 years) and probably average ca. 200-250 years. Site indices for 100 ft. (31 m) tall trees is relatively high, ranging between 65 and 100 years with the fastest growing trees in mesic sites adjacent to

Table 4: Area by cover types for CFRNA with code numbers for Holland (1986), SAF (Eyre 1980), and Kuchler (1966) classifications.

	% total	acres	hectares
HOLLAND TYPES			
Mixed Montane Chaparral (37510)	9.7	209	84.6
Wet Subalpine/Alpine Meadow (45210)	0.3	6	2.4
Dry Subalpine/Alpine Meadow (45220)	6.3	135	54.6
Montane Riparian Scrub (63500)	9.5	206	83.4
Sierran White Fir Forest (84240)	27.9	603	244.0
Red Fir Forest (85310)	27.1	585	236.7
Whitebark Pine/Mountain Hemlock (86220)	8.6	185	74.9
Alpine Talus and Scree Slope (91200)	10.7	231	93.5
unclassified	0.0	0	0.0
Total	100.0	2160	874.1
SAF COVER TYPES			
White Fir (211)	27.9	603	244.0
Red Fir (207)	27.1	585	236.7
California Mixed Subalpine (256)	8.6	185	74.9
unclassified	36.4	787	318.5
Total	100.0	2160	874.1
KUCHLER TYPES			
Mixed Conifer Forest (5)	27.9	603	244.0
Chaparral (29)	9.7	209	84.6
Red Fir Forest (7)	27.1	585	236.7
Alpine Meadows and Barren (45)	17.3	374	151.3
unclassified	18.0	389	157.5
Total	100.0	2160	874.1

Table 5: Density, frequency, cover, and importance values for trees (> 2m in height) in alluvial white fir forest, Clark Fork RNA.

species	density (per ha)	frequency (%)	cover (m^2/ha)	rel dens.	rel freq.	rel. cov.	imp. value
white fir	1310	100	201.23	0.956	0.625	0.808	238.9
Jeffrey pine	40	40	38.69	0.029	0.250	0.192	47.1
incense-cedar	20	20	0.02	0.015	0.125	0.000	14.0
totals:	1370	160	201.23	1.000	1.000	1.000	300.0

Table 6: Frequency and average cover values of herbs and shrubs on ten 10 x 10 m plots on alluvial white fir forest Clark Fork RNA.

species	mean % cover	frequency (%)
Symphoricarpos acutus	2.2	50
Graminae sp.	0.9	50
Ribes roezlii	0.7	50
Osmorhiza chilensis	0.7	50
Melica aristata	0.7	30
Kelloggia galioides	0.5	70
Silene lemmonii	0.3	40
Carex sp.	0.2	10
Sidalcea glauca	0.2	20
Hieracium albiflorum	0.2	30
Stephanomeria lactucina	0.1	40
Erigeron breweri	0.1	20
Thalictrum fendleri	0.1	20
Arceuthobium campylopodium	0.1	10
Aquilegia formosa	0.1	10
Eriogonum nudum	0.1	10
Polemonium californicum	0.1	10
Viola purpurea	-	30
Pyrola picta	-	20

Table 6 (continued):

species	mean % cover	frequency (%)
Amelanchier pallida	-	20
Arabis holboellii retrofracta	-	20
Apocynum pumilum	-	10
Chimaphila menziesii	-	10
Cirsium andersonii	-	10
Collomia tinctoria	-	10
Gayophytum sp.	-	10
	mean % cover: 7.3	

creeks and seeps. Winter snow depth, as indicated by *Letharia* lichen growth on tree trunks averages ca. 3 ft. (91 cm).

The surviving Jeffrey pines in this alluvial forest average ca. 4 ft. (1.2 m) dbh, 160-180 ft. (48.7-54.9 m) tall, and 350-400 years in age. As Talley (1977b) indicated for Onion Creek, the relative increase of white fir over the last century may relate to low fire frequency and increasing warmth and high precipitation 50-100 years ago. However, the numerous large white fir (42-48 inches, 107-122 cm dbh) also indicate the relative stability and long-term importance of white fir in the alluvial forest.

The alluvial stands have the highest basal area cover of any forest type in the CFRNA (201 m^2/ha) and the highest density of trees (1370/ha), saplings (780/ha), and seedlings (210/ha) of any of the sampled forest types.

Understory species include 26 species (Table 6). Although only one species (*Symphoricarpos acutus*) averages greater than 1% cover, only four species occur on 50% or more of the plots. Widely scattered openings with such species as *Gilia leptalea, Melica aristata,* and *Triteleia hyacinthina*, suggest that openings were more frequent prior to the increasing density of white fir in the past 100 years.

Transitional Phase: The second area sampled is in a transitional zone between the alluvial stands and the upper slope successional stands presently dominated by 65-80 year old white fir within a matrix of montane

chaparral. This transect is located in the e half of the sw 1/4 sec. 5 at the base of the steepening portion of the nw-facing slope, approximating the 6400 ft. contour (see map 3). Site conditions include a rocky soil with scattered boulders (Gerle family moderately deep), and slope steepness between 3 and 10°. Exposures are largely nw. Moisture conditions are more xeric than the alluvial type.

The history of this transitional forest is different than the previous type, largely due to a fire which affected the area about 80 years ago. The fire did not crown out extensively in the area of the transect, but it did in adjacent areas on gentle sw-facing slopes (s half, sw 1/4 sec. 5) and on steep nw facing slopes (se 1/4 sec. 5 and adjacent ne 1/4 sec. 8). The result, in those areas, are extensive monospecific stands of young white fir with dominants ranging from 1-2 ft. (31-64 cm) dbh and heights of 65-75 ft. (19.8-22.9 m). Much of this forest shows clear evidence of a seral stage of montane chaparral prior to the dominance of white fir (photo 4). The steeply sloping nw-facing slopes still have a high percentage of *Quercus vaccinifolia, Arctostaphylos nevadensis,* and *Chrysolepis sempervirens* shrubs surviving in the understory. While the gently sloping areas have only skeletal remnants of the chaparral understory.

The area sampled (tables 7 and 8) has a large number of surviving old stems of white fir, incense-cedar, and a smaller number of Jeffrey pine and sugar pine. Some of the largest, and probably oldest, trees seen in the white fir zone occur in this transitional forest, though they are widely scattered. These include white fir up to 72 inches (1.82 m), sugar pine up to 60 inches (1.52 m), Jeffrey pine to 50 inches (1.27 m), and incense-cedar to 84 inches (2.13 m) dbh (photos 5, 6, and 7). Many of these larger trees show evidence of repeated ground fire (cat-face scars). This is in contrast to the alluvial site, which has few fire-scarred trees. The higher percentage of other conifers and the higher frequency of ground fire suggests a less mesic moisture regime than the alluvial site. This is probably precipitated by the proximity to the upper slopes and the relatively shallow, rocky soil.

Table 7: Density, frequency, cover, and importance values for trees (>2 m tall) on ten 10 x 10 m plots on transitional alluvial/upper slope white fir forest, Clark Fork RNA.

species	density (per ha)	frequency (%)	cover (m^2/ha)	rel dens.	rel freq.	rel. cov.	imp. value
white fir	810	100	63.05	0.675	0.417	0.621	171.3
incense-cedar	320	80	22.25	0.267	0.333	0.219	81.9
Jeffrey pine	50	40	15.90	0.042	0.167	0.157	36.6
sugar pine	20	20	0.34	0.17	0.83	0.003	10.3
totals	1200	240	101.54	1.000	1.000	1.000	300.0

Table 8: Frequency and average cover values of herbs and shrubs on ten 10 x 10 m plots on transitional alluvial/upper slope white fir forest, Clark Fork RNA.

species	mean % cover	frequency (%)
Quercus vaccinifolia	0.7	20
Goodyera oblongifolia	0.1	70
Hieracium albiflorum	0.1	50
Viola purpurea	0.1	30
Graminae sp.	-	40
Kelloggia galioides	-	40
Symphoricarpos acutus	-	30
Aquilegia formosa	-	10
Apocynum pumilum	-	10
Arabis holboellii retrofracta	-	10
Chimaphila menziesii	-	10
Elymus glaucus	-	10
Gayophytum sp.	-	10
Gilia leptalea	-	10
Melica aristata	-	10
Stephanomeria lactucina	-	10
	total mean cover: 1.0	

Understory species are sparse in the sample, with very little cover, probably a result of the xeric and relatively shady understory with few openings and thick duff. The orchid, *Goodyera oblongifolia* is a constant associate, not sampled in the alluvial type. Other areas called white fir/ *Goodyera oblongifolia* forest have been sampled in the central and northern Sierra (Taylor and Randall 1977). They typically occur where snow cover is deeper than nearby mixed conifer or sugar pine-white fir forest (on higher elevations or more directly n-facing slopes. Snow depth in this transitional forest averages 4-5 ft. (1.2-1.5 m).

Sapling and seedling density in this sample is lower than in the previous alluvial type. White fir saplings average only 50/ha and seedlings are only 10/ha. Incense-cedar saplings average 140/ha (seedlings 20/ha), but are highly clumped.

North Slope Phase: The third area sampled is representative of steep, rocky n-facing slopes within the white fir zone. These areas (s portion of sec. 33 and n 1/2 sec. 4) are underlain by rocky granitic soils (Gerle family moderately deep - Rock outcrop complex, 35-60% slopes). The steep n aspect and the rocky soil tend to slow growth of the dominant white fir (photo 8). Site index (based on 3 trees) is much lower for white fir than the alluvial sites, with 100 year old trees ranging from 50-75 ft. (15-23 m) in height and averaging ca. 12 inches (32 cm) dbh. Average dominant white fir are 2.5- 3 ft. (76-91 cm) dbh and 120-130 ft. (37-40 m) tall. Sugar pine and Jeffrey pine are occasional members of the canopy, but are less constant than in the previous transitional type. There are rare individuals of western white pine (*Pinus monticola*) and red fir. These species increase in abundance above ca. 7000 ft. (2156 m).

The transect in this phase was run parallel with the slope direction, averaging between 355° and 10° corrected compass bearing. The transect ran from between ca. 6320 and 6880 ft. (1930-2097 m). Slope steepness averages between 30 and 45° with boulders and rocks covering between 15 and 35% of the surface. Tables 9 and 10 present the data.

Table 9: Density, frequency, cover, and importance values for trees (>2 m tall) on ten 10 x 10 m plots on north-facing slope white fir forest, Clark Fork RNA.

species	density (per ha)	frequency (%)	cover (m^2/ha)	rel dens.	rel freq.	rel. cov.	imp. value
white fir	950	100	65.55	0.931	0.588	0.872	239.1
Jeffrey pine	30	30	2.35	0.029	0.176	0.031	23.6
sugar pine	20	20	7.25	0.020	0.118	0.096	23.4
incense-cedar	20	20	0.05	0.20	0.118	0.001	13.9
totals	1020	170	75.20	1.000	1.000	1.000	300.0

Table 10: Frequency and average cover values of herbs and shrubs on ten 10 x 10 m plots on north-facing slope white fir forest, Clark Fork RNA.

species	mean % cover	frequency (%)
Quercus vaccinifolia	5.2	90
Symphoricarpos acutus	5.0	90
Acer glabrum torreyi	1.1	60
Hieracium albiflorum	0.4	50
Ribes roezlii	0.3	50
Erigeron breweri	0.3	30
Osmorhiza chilensis	0.3	50
Graminae sp.	0.2	30
Gilia leptalea	0.2	20
Phacelia racemosa	0.2	20
Thalictrum fendleri	0.2	20
Kelloggia galioides	0.1	40
Deschampsia elongata	0.1	10
Viola purpurea	0.1	10
Apocynum pumilum	-	40
Arabis holboellii retrofracta	-	20
Chimaphila menziesii	-	20
Gayophytum sp.	-	20
Penstemon sp.	-	20
Allium campanulatum	-	10

Table 10 (continued):

species	mean % cover	frequency (%)
Amelanchier pallida	-	10
Arceuthobium campylopodium abietinum	-	10
Chenopodium sp.	-	10
Circaea alpina pacifica	-	10
Elymus glaucus	-	10
Erigeron inornatus	-	10
Eriogonum nudum	-	10
Galium aparine	-	10
Hackelia sp.	-	10
Microsteris gracilis	-	10
Pedicularis semibarbata	-	10
Polygonum sp.	-	10
Pyrola picta	-	10
Senecio integerrimus	-	10
Smilacina racemosa amplexicaulis	-	10
Stipa columbiana	-	10
Urtica holosericea	-	10
total mean cover: 13.7		

The density and cover of trees on this north-facing forest is lower than in the alluvial and transition forests. However, diversity of understory species is higher than other white fir forests in the area (36 species of herbs and shrubs averaging 14% cover). Reproduction is sparse with no seedlings noted on any of the plots and white fir the only sapling species present (380/ha). Incense-cedar is conspicuous by its general absence in this forest, while sugar pine and Jeffrey pine are in near equal low density.

The rocky substrate and shady north exposure probably account for the lower density and cover of trees, while the high diversity of understory species relates to mesic understory conditions (with scattered moist seeps and alder runs), and small rocky openings with sufficient light to allow understory species growth.

Mixed Conifer Phase: The final subtype of white fir forest sampled occurs on nw to w-facing slopes. It is the only white fir type in the area which is not regularly dominated by white fir in the canopy. On the vegetation map it is shown as upper elevation mixed conifer forest. Although in stem density,

white fir is the dominant, basal area and canopy cover may be traded between any of four species. Typically Jeffrey pine dominates on w-facing exposures while white fir dominates on the nw-facing slopes. Sugar pine and incense-cedar are most important in the canopy at lower elevations (<6600 ft.,2012 m).

Slopes average between 20° and 45° and soil is largely rocky and 20-30 inches deep (Gerle moderately deep association). The understory is dominated by montane chaparral species in higher cover than in all other types of mature forest in the white fir zone at CFRNA (photo 9). On the lower slopes in the most highly mixed stands, dominant sugar pine and Jeffrey pine are regularly over 180 ft. (55 m) in height with the tallest reaching 200 ft. (61 m). All major species may reach diameters between 4 and 6 ft. (1.2-1.8 m). Growth rates for white fir appear to be relatively fast at the lower elevations. One individual @ ca. 20 inches (51 cm) from the base with a diameter of 50.5 inches (128 cm) was only 218 years old. Jeffrey pine appears to grow somewhat more slowly under similar conditions. One Jeffrey pine @ 30 inches (76 cm) from the base was 61 inches (155 cm) in diameter and approximately 350 years old.

The transect sampling this forest type was run down a nw-facing slope (mean declination: 302°) in the nw 1/4 sec. 4 and the adjacent ne 1/4 sec. 5. Elevations ranged between 6400 and 6900 ft. (1951-2103 m). The transect was placed in a transitional zone between white fir basal area dominance and co-dominance with other species. Unlike some other slopes with more due-west exposures, Jeffrey pine is relatively low density and cover, with a concomitant increase in white fir canopy cover. Tables 11 and 12 present the data.

Compared to other white fir phases this type has relatively high basal area cover, low tree density, and relatively high sapling density. Saplings average 520/ha with all four major tree species represented (white fir and incense cedar most numerous). Seedling density is low, averaging 70/ha for all species. The understory cover is relatively high with scattered clumps of montane chaparral species dominating. Shrub and herb diversity is moderately low.

Successional Phase: This is the only major phase of white fir forest not represented in the vegetation samples. It is dominated by young poles of white fir emerging through a varying cover of mixed montane chaparral

(photo 10). It is the result of extensive crown fire occurring approximately 80 years ago on much of the w and nw-facing slopes between 6400 and 8000 ft. (1950-2438 m). There are very few older trees that survived this fire. Most individuals are 12-24 inches (30-61 cm) dbh and ca. 45-60 ft. (14-18 m) in height. Densities are variable with high density clumps separated by rocky open areas dominated by mats of *Arctostaphylos nevadensis* and *Quercus vaccinifolia*. Semi-shaded areas tend to have understories dominated by *Chrysolepis sempervirens*. Herbs are sparse and include such species as *Penstemon laetus, Allium campanulatum, Arabis platysperma, A. holboellii* var. *retrofracta, Gayophytum* sp., *Eriogonum nudum,* and *Monardella odoratissima* ssp. *pallida*.

Growth rates of the dominant young firs are variable depending on exposure and shading. White fir ranging from 7 inches to 20 inches (18-51 cm) dbh were all aged at between 73 and 75 years.

White fir is the clear dominant up to 7600 ft. (2316 m) on these w-facing slopes, at which point red fir begins to dominate as similar sized trees. The effects of the past crown fire reach up into the red fir forests above 8000 ft. (2438 m) on some w-facing slopes.

Table 11: Density, frequency, cover, and importance values for trees (>2 m tall) on ten 10 x 10 m plots on northwest-facing slope white fir-mixed conifer phase, Clark Fork RNA.

species	density (per ha)	frequency (%)	cover (m^2/ha)	rel dens.	rel freq.	rel. cov.	imp. value
white fir	550	100	46.38	0.567	0.476	0.298	134.1
incense-cedar	310	50	43.03	0.320	0.238	0.276	83.4
sugar pine	80	30	39.95	0.82	0.143	0.257	48.2
Jeffrey pine	30	30	26.45	0.031	0.143	0.170	34.4
totals	970	210	155.76	1.000	1.000	1.001	300.1

Table 12: Frequency and average cover values of herbs and shrubs on ten 10 x 10 m plots on north-facing slope on northwest-facing slope white fir-mixed conifer phase, Clark Fork RNA.

species	mean % cover	frequency (%)
Quercus vaccinifolia	9.3	60
Arctostaphylos nevadensis	4.5	10
Chrysolepis sempervirens	2.3	20
Ribes roezlii	0.4	20
Chaenactis douglasii	0.2	10
Stipa columbiana	0.2	20
Ceanothus cordulatus	0.2	10
Symphoricarpos acutus	0.1	40
Apocynum pumilum	-	40
Gayophytum sp.	-	30
Arabis platysperma	-	20
Erigeron breweri	-	20
Hieracium albiflorum	-	20
Sitanion hystrix	-	20
Silene lemmonii	-	20
Arceuthobium campylopodium abietium	-	10
Bromus richardsonii	-	10
Chimaphila menziesii	-	10
Eriogonum nudum	-	10
Kelloggia galioides	-	10
Pyrola picta	-	10
Viola purpurea	-	10
total mean cover: 17.2		

Red Fir Forest:

The red fir forest is well developed in the CFRNA. It occurs on both volcanic and granitic substrates and ranges from elevations as low as ca. 7000 ft. (2134 m) on sheltered ne-facing slopes to about 8800 ft. (2682 m) on w-facing ridges (photo 11). Red fir is the clear dominant throughout the majority of this forest type. Other tree species present in the forest include white fir, western white pine, Jeffrey pine, mountain hemlock, and Sierra juniper (*Juniperus occidentalis* ssp. *australis*).

White fir is a significant component of the lower elevation red fir stands, but quickly drops out within a few hundred vertical feet of the point where red fir canopy dominance begins. Barbour (1988) suggests that the ecotone between red and white fir dominated forests averages ca. 492 ft. (150 m) of

elevation. The principal reason for the two species' changing dominance over a relatively short distance may result from differing phenological responses to soil and temperature. Leaf bud opening is 2-3 weeks earlier and leaf conductance is lower for white fir than red fir growing side by side in the central Sierra Nevada (Barbour op cit.).

Western white pine is a constant low-density tree at low and mid-elevations, but assumes greater importance at the upper elevations. Small groves of nearly pure western white pine occur on both granitic and volcanic substrates between ca. 8400 and 8800 ft. (2560-2682 m), but in this report these stands are considered a phase of the red fir forest, because of their small extent and constant association with red fir (photo 12).

Jeffrey pine and Sierra juniper are of low importance in the red fir forest. Both species tend to be associated with rocky and relatively xeric sites, most particularly true with the latter species. Mountain hemlock is present in small quantities, usually as small understory trees on high elevation n slopes.

Dominant red fir and western white pine attain diameters of 40-50 inches breast height and heights of 120-140 ft. (37-43 m). All red fir cones examined were typical of the species (non with exserted bracts).

In general, red fir forest on granitic soils tends to be more open, with a higher representation of understory species than red fir forest on volcanics. The relatively high cover of boulders and other surface rock on granite may restrict germination sites and the higher frequency of destructive crown fire, avalanche damage and other disturbance factors may also play a role in the lower tree density on granitics compared to volcanics. Understory composition of the granitic stands includes *A. nevadensis, Q vaccinifolia,* and *Chrysolepis sempervirens. Acer glabrum* var. *torreyi* is a common member of the understory on steep rocky northerly facing slopes. Herbs include; *Chrysopsis breweri, Erigeron breweri, Haplopappus whitneyi, Stipa occidentalis, Poa nervosa, Stephanomeria lactucina, Senecio integerrimus, Juncus parryi,* and *Ivesia lycopodioides*.

Rock Outcrop Communities (91200):

Much of the upper elevation terrain of CFRNA is very steep and composed of colluvial deposits or bedrock outcrops of granitic or volcanic rock (photo

13). The flora of these cliff and talus areas is relatively low diversity and to some degree overlaps with the subalpine and alpine dry meadows. However, many of the lower elevation species occurring on granitics are not found at upper elevations. These include: *Sedum obtusatum* ssp. *boreale, Cheilanthes gracillima, Eriogonum umbellatum* ssp. *stellatum, Ipomopsis aggregata, Agastache urticifolia, Leptodactylon pungens, Arenaria kingii,* and *Eriogonum marifolium*.

The volcanic outcrops were not thoroughly investigated during this survey. However, several species such as *Astragalus lentiginosus var. ineptus, Polemonium pulcherrimum, Eupatorium occidentale, Juncus parryi, Pellaea breweri, Melica stricta,* and *Erigeron compositus* appear to be strongly associated with them.

Montane Chaparral (37510):

The montane chaparral at CFRNA may be either successional or edaphic climax. The successional types occur in two phases, the most extensive of which is associated with white or red fir-dominated forests and relates to the most recent extensive fires, which destroyed the canopy of fir ca. 80 years ago (see photo 10). The other type of seral montane chaparral is associated with avalanche chutes as can be found in the western half of sec. 3 (photo 14). Edaphic climax chaparral occurs adjacent to granitic outcrops in small areas throughout the mid and lower elevations.

Regardless of the successional history, most montane chaparral in the CFRNA is similar in composition. *Quercus vaccinifolia* is the overall dominant. This shrub typically forms dense stands ca 3-5 ft. (0.9-1.5 m) in height. Associated with this species are other shrubs such as *Ceanothus cordulatus, C. velutinus, Chrysolepis sempervirens,* and *Arctostaphylos nevadensis. Arctostaphylos patula,* a common associate of these species in most other montane chaparral stands in the northern Sierra Nevada was not noted here. Shade and moisture tolerance of the dominant shrubs varies to some degree with *Q. vaccinifolia* tolerant of modal conditions, *A. nevadensis* of shallow and very well drained soils, and *C. sempervirens* more tolerant of shade than other species. Other subordinate species include *Holodiscus boursieri, Prunus emarginata,* and *Ribes montigenum*.

Herbaceous species are generally scarce and similar to those characteristic of the granitic rock outcrop community, previously described.

Montane Riparian Scrub (63500):

Mountain alder and several species of willows (*Salix* spp.) form dense thickets associated with seeps, rivulets, and streams throughout the CFRNA. Thickets dominated by mountain alder are the most widespread of the shrub-dominated riparian types. These are largely restricted to the granitic slopes of the lower and middle elevations. These "alder runs" typically line plunging ravines and narrow canyons which are frequently scoured by avalanches (photo 15). However, unlike the *Alnus sinuata* avalanche communities of the North Cascades of Washington (Franklin and Dyrness 1973) these scrubs are strongly tied to permanent flowing moisture. The bowed stems of the shrubs suggests heavy winter snow loads and resistance to damage from recurrent avalanches. Other shrubs associated with the mountain alder thickets include *Ribes nevadense, Cornus stolonifera,* and occasional *Salix ligulifolia, S. lutea,* and *S. scouleriana*.

Beneath the canopy of 3-4 m tall shrubs is a lush layer of herbs and graminoids. These include *Aconitum columbianum, Actaea rubra ssp. arguta, Agrostis scabra, Anaphalis margaretacea, Aquilegia formosa, Arnica amplexicaulis, A. diversifolia, Artemisia douglasiana, A. ludoviciana* ssp. *incompta, Athyrium filix-femina, Bromus laevipes, Calamagrostis canadensis, Cardamine breweri, Carex fracta, C. gymnoclada, C. jonesii, C. nebrascensis, Castilleja miniata, Circaea alpina* var. *pacifica, Cystopteris fragilis, Delphinium glauca, Deschampsia elongata, Epilobium brevistylum, Erigeron coulteri, Galium triflorum, Gentiana calycosa, Geum macrophyllum, Glyceria striata, Heracleum lanatum, Juncus nevadensis, Lilium kelleyanum, Mimulus guttatus, M. lewisii, Potentilla glandulosa* ssp. *nevadensis, Saxifraga punctata* ssp. *arguta, Senecio serra, S. triangularis, Urtica holosericea,* and *Viola glabella.*

Mountain alder thickets are occasional at lower elevations on slopes not subjected to avalanches. In such locations they line low gradient streams and seepy areas where they typically do not form a dense continuous cover. Occasional trees of aspen and black cottonwood occur in these situations. The herbaceous understory is similar to the more extensive avalanche-type.

At upper elevations above ca. 8400 ft. (2560 m) mountain alder is replaced by *Salix orestera*. These willow thickets occur up to ca. 9000 ft. (2743 m) in some areas, with a similar understory to the mountain alder thickets.

Whitebark Pine-Mountain Hemlock (86210):
Subalpine forests with these two species dominant occur on volcanic substrate above ca. 8400 ft. (2560 m). Mountain hemlock is more common and widespread than whitebark pine. Both species occur together on w-facing and nw-facing slopes (photo 16); however, whitebark pine tends to dominate on ridgecrests and sw-facing slopes and mountain hemlock dominates on more northerly exposures. Stature of the dominants varies depending on exposure. The high elevation stands of whitebark pines and mountain hemlock are krummholz (photo 17). Best developed forests of this type occur in the basin n of Bald Peak where mountain hemlock reaches 3 ft. (91 cm) dbh and heights of ca. 70 ft. (21m). Western white pine is occasional in this basin and a few stands dominated by lodgepole pine occur in mesic areas on relatively gentle slopes (photo 18), usually adjacent to wet meadows (Note: One such lodgepole stand is large enough to show on map 3). These lodgepole pine stands are usually intermixed with whitebark pine and mountain hemlock and approach the California mixed subalpine forest (SAF 254) described in Eyre (1980).

The understory vegetation is variable in these forests. High elevation krummholz whitebark stands have a sparse understory of *Ribes montigenum, Symphoricarpos vaccinioides, Wyethia mollis,* and *Osmorhiza occidentalis*. North slope, mixed stands of hemlock and whitebark pine have *Artemisia douglasii, Lupinus meconanthus, L. andersonii* var. *apertus, Angelica lineariloba, Haplopappus macronema,* and *Achillea millefolium.* Tall mountain hemlock-dominated forest on w-facing slopes has *Monardella odoratissima* ssp. *pallida, Lupinus andersonii, Stipa occidentalis, Bromus richardsonii, Cirsium andersonii, Arnica cordifolia, Angelica lineariloba,* and *Polemonium californicum*. Lodgepole pine-dominated stands may have a dense understory of *Artemisia rothrockii, Veratrum californicum,* and other mesophilic species.

Dry Subalpine-Alpine Meadow (45220, 91120):
West- and southwest-facing, moderately steep slopes on volcanic soil are dominated by a low density herbaceous and sub-shrub cover. The soil is more friable and has fewer boulders and outcrops than adjacent granitic terrain or volcanic cliff and talus slopes. Thus herb density and diversity is greater than on these other substrates. Species composition is substantially different than on granitic slopes. However, because the volcanics are at higher elevation than the granitics it is difficult to

separate the effects of climate and substrate on the vegetation. The subalpine-to-alpine vegetation of these volcanic slopes is not well accounted for by Holland (1986), who partially included them within Sierra Nevada Fell-field (code # 91120) and dry alpine/subalpine meadows (45220). Because the association is not truly alpine throughout, I have chosen to call it by the latter name.

Perhaps the most similar series of subalpine and alpine communities are those sampled on volcanics at Carson Pass described by Major and Taylor (1977), considered as alpine steppe. Most of the species characteristic of the subalpine volcanic dry meadows of the Clark Fork RNA occur in three community types of Major and Taylor. These are the *Haplopappus acaulis-Leptodactylon pungens* ssp. *pulchriflorum* ; the *H. acaulis-Tetradymia canescens* ; and the *H. acaulis-Geum canescens* communities. These three communities are divided into 6 species groups with characteristic environmental distinctions. The groups vary from relatively deep snow accumulation (ca. 1 m) to extremely windblown sites with little or no snow accumulation. Rock cover and soil depth also vary with characteristic variation in species composition.

The short reconnaissance period in the alpine-subalpine steppe vegetation zone of CFRNA (ca. 2 hours) was not sufficient to further differentiate the series. However, much of phytosociological interest exists in this area for those willing to ascend the steep slopes to access it (photos).

At CFRNA the subalpine steppe vegetation consists of the following species: *Anemone drummondii, Artemisia arbuscula, A. douglasiana, A. rothrockii, Castilleja breweri , Crepis acuminata , Cryptantha crymophila, Dicentra uniflora, Erigeron barbellatus, Erigeron compositus, Eriogonum ovalifolium* var. *nivale, Eriogonum umbellatum, Eriogonum wrightii* var. *subscaposum, Eriophyllum lanatum* var. *monoense, Geum canescens, Haplopappus acaulis, Haplopappus bloomeri, Haplopappus macronema, Haplopappus suffruticosus, Linum lewisii, Lomatium nevadense, Monardella odoratissima* ssp. *pallida, Orthocarpus copelandii, Penstemon bridgesii, Phacelia frigida, Phlox caespitosa* ssp. *pulvinata, Poa epilis, Ribes cereum, Senecio canus, Sitanion hystrix, Stipa occidentalis, Symphoricarpos vaccinioides, Thelypodium flexuosum,* and *Wyethia mollis.*

In addition to the herbs and subshrubs, occasional trees of Sierra juniper,

western white pine, whitebark pine, mountain hemlock, red fir and lodgepole pine also occur. Most of the individuals are stunted as a result of the high exposed locations and shallow soils.

Wet Subalpine-Alpine Meadows (45210):

At low and mid elevations in the CFRNA most wet areas are limited to narrow ravines and canyons where the montane riparian scrub dominates. The only sizeable areas of non-shrubby vegetation with permanently wet to moist soil occur on volcanic substrates at high elevations. Several well developed meadows occur in the subalpine zone. Each is dominated by a different set of species largely depending upon moisture availability. The most extensive wet meadows occur along the drainage immediately to the north of Bald Peak. Species dominating these meadows include *Allium vallidum, Delphinium glauca, Calamagrostis canadensis, Carex jonesii, Carex nebrascensis, Cardamine breweri,* and *Veratrum californicum*. Other meadows on sw-facing slopes contain such species as *Aster foliaceus* var. *parryi, Dodecatheon alpinum, Mimulus primuloides var. pilosellus, Helenium hoopesii, Gentiana calycosa, Arnica mollis, Veratrum californicum, Carex abrupta, Carex gymnoclada, Carex illota, Phleum alpinum, Sphenosciadium capitellatum,* and *Epilobium hornemannii.*

FAUNA

A total of 49 species of vertebrates were detected from the CFRNA during the visit for the ecological survey (Appendix 2). Most species are typical of the montane zone of the central Sierra. Despite the relatively large areas of subalpine and alpine vegetation, only a few alpine species such as the alpine chipmunk (*Tamias alpina*) and the pika (*Ochotona priniceps*) were noted. The most common vertebrates in the area include red-breasted nuthatch (*Sitta canadensis*), dark-eyed junco (*Junco hyemalis*), mountain pocket gopher (*Thomomys monticola*), Douglas squirrel (*Tamiasciurus douglasii*), and long-eared chipmunk (*Tamias quadramaculatus*).

Diversity and numbers of breeding birds are likely to be higher during the spring and early summer months than at the time of the survey. The late August survey date is largely after a number of species have stopped breeding activities and thus, their detectability is reduced.

GEOLOGY

Rocks of the CFRNA are of two types: granitic and volcanic. The granites are typical of those throughout the central Sierra Nevada and are largely quartz monzonite and granodiorite (Bateman and Wahrhaftig 1966). The volcanics are part of the Stanislaus Formation, a series of latites which erupted near the Sierra crest about nine million years ago in the Miocene and early Pliocene (Slemmons 1966). The source of at least part of the Stanislaus Formation (indicated by a number of augite latite dikes) lies between Dardanelles Cone a few miles nw of the RNA and Sonora Pass (a few miles east of the RNA). Thus, the RNA itself, may be part of the source for these flows, which stretch both west and east for many miles. The type locality for the Stanislaus Formation is between Bald Mountain and Red Peak and may be considered to include the CFRNA (see map 5 for area covered by volcanics).

Locally, the flows are represented by dark-to-reddish basaltic flows and latites (Dardanelles Member at highest elevations and possibly the Table Mountain Member at lower elevations) as well as several welded tuff flows and latites sandwiched between the two (the Eureka Valley Member). The most conspicuous of the tuff flows is very pale (nearly white) and outcrops at the western base of Bald Peak in the NE 1/4 sec. 16 and adjacent parts of sec. 9 (see photo 21). Color and consistency of the volcanics is highly variable ranging from heavy massive dark basalts to reddish blocky basalts, to pale brown quartz latites, and finally to the whitish tuff.

SOILS

The soils of the CFRNA are differentiated into seven mapping units in the most recent draft order three soil survey of the area (Stanislaus National Forest 1986). Following are brief descriptions of the mapping units, which may be located on Map 6. Code numbers following the names are those used on map 6.

Andic Cryumbrepts - Lithic Cryumbrepts - Rock outcrop complex, 20-70% slopes (101): This map unit occurs on craggy mountains and consists of 40% Andic Cryumbrepts, 30% Lithic Cryumbrepts, and 15% rock outcrop. Included are 15% small areas of deep soils formed in colluvium or glacial till. Andic Cryumbrepts consist of moderately deep to deep soils formed from weathered andesitic tuff. The surface layer is brown gravelly loam ca. 9

inches (23 cm) thick. The subsoil is yellowish brown gravelly sandy loam ca. 19 inches (48 cm) thick. Rock fragment content is 5-40%. Depth to weathered bedrock is 20-50 inches (51-127 cm). Lithic Cryumbrepts are shallow soils formed from tuff. Typically these soils are brown loam ca. 5 inches (13 cm) deep over hard fractured andesitic tuff. Rock fragment content is 5-60%. Depth to bedrock is 4-20 inches (10-51 cm). Rock outcrop in this unit consists of weakly to moderately consolidated andesitic tuff, usually rough and bare with shallow pockets of gravelly detritus.

Gerle Family moderately deep, deep - Rock outcrop complex 5-35% slopes (122). The moderately deep portion is derived from granitic rocks, colluvium, or glacial till. Typically the surface layer is very dark brown sandy loam about 10" (25 cm) thick sub-soil is light brown sandy loam about 20" (51 cm) thick. Rock fragment content is 25-35%, depth to consolidated glacial till or bedrock is 20-40" (51-102 cm). The deep portion is derived from granitic rock, usually glacial till. Typically the surface layer is dark gray sandy loam about 10" (25 cm) thick. Sub-soil is light brownish-gray sandy loam about 65" (165 cm) thick rock fragments 5-30%, depth to glacial till is more than 40" (102 cm). The rock outcrop component is exposed granitic bedrock. Locally this unit occurs in the valley bottom alluvial area in the sw corner of the RNA.

Gerle Family moderately deep - deep - Rock outcrop complex 35-60% slopes (123). This mapping unit is essentially similar to the previous one except it occurs on steeper slopes. Locally it occurs on the steeper w- and n-facing slopes on the northern side of the RNA.

Gerle Family moderately deep - Rock outcrop complex, 35-60% slopes (125): This map unit is on undulating mountain sides. This unit is 40% Gerle family moderately deep and 40% rock outcrop with small inclusions of Gerle, Lithic Xerumbrepts and other deep bouldery soils.

Lithic Cryumbrepts - Rock outcrop complex (165): This unit is on steep mountain slopes, locally represented on the talus slopes and solid on the north face of Bald Peak. Both of the components of this unit have been previously described.

Lithic Xerumbrepts - Fiddletown family, moderately deep - Rock outcrop, 35-70% slopes (170): This unit occupies south to west-facing slopes of mountains. It is made up of 40% Lithic Xerumbrepts (under montane

chaparral and 20% Fiddletown family under fir-dominated coniferous forest, and 20% rock outcrop. There are 20% inclusions of Dystric Xerophrepts and Holland, moderately deep and Ovall families. Lithic Xerumbrepts are shallow soils formed from granitic rock. Typically the surface layer is dark grayish brown loamy sand about 7 inches (18 cm) thick. The soil is brown sandy loam about 10 inches (25 cm) thick. Rock fragment content is 10-40%. Depth to hard fractured bedrock is 4-20 inches (10-51 cm). Fiddletown Family, moderately deep consists of soils from granitic rocks. The surface layer is dark brown gravelly sandy loam ca. 20 inches (51 cm) thick. The subsoil is brown very gravelly sandy loam ca. 10 inches (25 cm) thick. Rock fragment content is 35-60%. Depth to hard fractured bedrock is 20-40 inches (51-102 cm). Rock outcrop in this unit consists of exposed granitic bedrock, usually as crags or cliffs. with soil only in fractures.

Rock outcrop (183). This unit covers a portion of the upper elevations. Typically there is less than 15% of soil inclusions with enough soil to support plants. Rocks are principally volcanic tuff and basalt flows.

IMPACTS

Direct Human Impact:
Much of the northern boundary of the CFRNA is bordered by multiple use land, which has been logged and developed for recreation. However, despite the close proximity to the Clark Fork Campground and horse camp, very little recreational use is made of the RNA. The steep slopes and lack of trails within the area are largely responsible for this fact.

Tonnesen (1981) mentions sanitation and stand maintenance logging in the campground area. Logging has occurred for many years with some stems cut over 40 years ago. The logging with the greatest impact on the area occurred ca. 20 years ago in the NE 1/4 of the SW 1/4 sec. 5. The small area of exclusion shown on the RNA maps in the vicinity of the water tanks (e.g., see map 2) was drawn to exclude the effects of this selective logging operation from the RNA. Within the boundaries as defined in this report there is no significant impact from any logging operation.

There are two water tanks (ca. 10,000 gallons each) adjacent to the sw boundary in the ne 1/4 sw 1/4 sec. 5. These are used as a water supply for the campground. As noted before, these are incorrectly shown on the maps and actually occur on the n side of the small permanent tributary to Clark Fork. The tanks are fed by a plastic pipe system heading at a small coffer

dam (ca. 2 ft. tall) along the aforementioned tributary. As the boundaries are presently drawn, the effects of this dam and pipe system are excluded from the RNA.

An unimproved fisherman's trail (not shown on maps) runs along the Clark Fork, paralleling it about 50-150 ft. (15-46 m) back from the edge of the stream. It receives moderate use, mostly from campers staying at the Clark Fork Campground. This trail runs through some of the alluvial white fir forest in the sw 1/4 sec. 5. As a result, the boundaries in this report are drawn to exclude the trail and the land to the north between it and the Clark Fork. No camp sites of any kind were noted within the proposed RNA.

Indirect and Potential Impacts:
Cattle grazing has occurred in the area in the past. It has largely been restricted to the upper elevations on the open volcanic terrain. No cattle were seen during the survey. However, a cow skeleton, several years old was noted at the head of the drainage just n of Bald Peak at about 9200 ft. (2804 m). The meadows and alpine steppe vegetation did not show any current signs of grazing, but the relatively high density of *Wyethia mollis* in parts of this area may indicate past overgrazing.

The entire CFRNA is within the Bald Peak Planning Area, a likely addition to the Carson-Iceberg Wilderness Area. Should this area be formally designated, one would expect increased recreational focus on the region containing the proposed RNA. The establishment of the CFRNA within a Wilderness Area would not necessarily negatively influence its research value and the rugged terrain and lack of trails would minimize the potential impact.

BOUNDARY CHANGES

The originally proposed boundaries and the currently proposed boundaries are shown on map 3. The primary justifications for enlarging the boundaries as described in this report involve representation of the extensive north slope stands of white fir in secs. 4 and 33, the inclusion of the productive alluvial stands of white fir in the sw 1/4 sec. 5, and the inclusion of the entire watershed system draining the north slope of Bald Peak. The boundary originally proposed by the Forest considered only part of the core area of white fir dominance in the vicinity of the RNA and used contour lines to delineate the upper elevation limit of the RNA. A natural topographic boundary including complete watershed systems will allow more use to be made of the entire area for controlled ecosystem studies, will facilitate

management of the area (e.g., no up-slope negative effects associated with recreation or cattle grazing), and insure representation of the target element following natural short-term or long- term alteration of the distribution and representation of the target element (e.g., fire or climate change).

MANAGEMENT CONCERNS AND RECOMMENDATIONS

The principal management questions for the CFRNA center on the policy of fire use and suppression. Many of the white fir stands at the lower elevations, particularly in the southern half of sec. 5 are densely grown with pole size white fir. The management plan for this RNA will have to carefully consider the use of prescribed fire and also consider fire suppression policies in the adjacent heavily used recreational lands.

Conceivably, should fire be excluded from this area for several more decades, a large percentage of the white fir stems will die from overcrowding, and self-thinning will take place. Prescribed fire in such high stand density areas would be tricky and potentially dangerous due to the nearby recreational development and the potential for extensive crown fire outside of the RNA. The natural irregularity of the fire cycle in the white fir zone suggests that attempts at maintaining an open understory and mature canopy are not necessarily correct. I suggest a let-burn policy for the RNA if possible, and otherwise avoiding attempts to regulate the target element through fire prescriptions.

I strongly recommend the establishment of the Clark Fork RNA. As a representative of the white fir forest for the northern Sierra it is excellent because of its diversity of stand types. Its potential research value is also high for several other vegetation types including red fir, montane riparian scrub, and alpine-subalpine dry meadows.

LITERATURE CITED

Barbour, M.G. 1988. Californian upland forests. In: Barbour, M.G., Billings, W.D., eds. North American Terrestrial Vegetation. Cambridge; New York: Cambridge Univ. Press.

Bateman, P.C. and C. Wahrhaftig. 1966. Geology of the Sierra Nevada. In E.H. Bailey (ed.) Geology of Northern California. Calif. Div. Mines and Geol. Bull. 190.

Borchert, M. and M. Hibberd. 1984. Gradient analysis of a north slope montane forest in the western Transverse Ranges of Southern California. Madrono 31:129-139.

Conard, S. G. and S.R. Radosevich. 1982. Post-fire succession in white fir (*Abies concolor*) vegetation of the northern Sierra Nevada. Madrono 29:42-56.

Department of Water Resources. 1988. 1988. California snow survey measurement schedule. State of California, Sacramento.

Eyre, F.H. (ed.) 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington D.C.

Franklin, J. F. 1988. Pacific Northwest forests. In: Barbour, M.G., Billings, W.D., eds. North American Terrestrial Vegetation. Cambridge; New York: Cambridge Univ. Press.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service Pacific Northwest Forest and Range Experiment Station.

Goodridge, J.D. 1981. California Rainfall Summary. State of California Dept. Water Resources.

Gordon, D.T. 1980. White fir. In: Eyre, F.H. (ed.) 1980. Forest cover types of the United States and Canada.Society of American Foresters, Washington D.C.

Holland, R. 1986. Preliminary descriptions of the terrestrial natural communities of California. Unpublished mimeo available from Calif. Dept. Fish and Game, Sacramento.

Keeler-Wolf, 1990. Ecological surveys of Forest Service Research Natural Areas in California. U.S.D.A. Forest Service Pacific Southwest Research Station Gen. Tech. Rep. PSW-125.

Kuchler, W. 1966. Potential natural vegetation. U.S. Dept. Interior Geol. Survey. 1969.

Laacke, R.J. and J.N. Fiske. 1983. Red fir and white fir. In: R. Burns (Tech. Comp.). Silvicultural Systems for the major forest types of the United States. USDA Forest Service Agriculture Handbook 445.

Major, J. and D.W. Taylor. 1977. Alpine. In M.J. Barbour and J. Major (eds.) Terrestrial vegetation of California. Wiley-Interscience. New York.

Matayas, W.J. and I. Parker. 1980. CALVEG, mosaic of existing vegetation of California. Regional Ecology Group, USDA Forest Service, San Francisco.

Munz, P.A. 1968. A California flora and supplement. University of California Press, Berkeley and Los Angeles.

Rantz, S.E. 1972. Mean annual precipitation in the California region. USGS Map, Menlo Park, California.

Rundel, P.W., D.J. Parsons, and D.T. Gordon. 1977. Montane and subalpine vegetation of the Sierra Nevada and Cascade Ranges. In M.J. Barbour and J. Major (eds.) Terrestrial vegetation of California. Wiley-Interscience. New York.

Sawyer, J.O. and D. Thornburgh. 1977. Montane and subalpine vegetation of the Klamath Mountains. In M.J. Barbour and J. Major (eds.) Terrestrial vegetation of California. Wiley-Interscience. New York.

Slemmons, D.B. 1966. Cenozoic vulcanism of the Central Sierra Nevada, California. In E.H. Bailey (ed.) Geology of Northern California. Calif. Div . Mines and Geol. Bull. 190.

Talley, S. N. 1977a. An ecological survey of the Babbitt Peak candidate Research Natural Area on the Tahoe National Forest. Unpublished report on file at Pacific Southwest Research Station, Berkeley.

Talley, S. N. 1977b. An ecological survey of the proposed Onion Creek candidate Research Natural Area on the Tahoe National Forest. Unpublished report on file at Pacific Southwest Research Station, Berkeley.

Thorne, R.F. 1976. The vascular plant communities of California, pp. 1-31 In: Latting, J. (ed.). Plant communities of southern California. Special Publication 2, California Native Plant Society, Berkeley, Calif.

Tonnesen, J.E. 1981. Preliminary reconnaissance report; Clark Fork Candidate RNA. Report on file at Stanislaus S.O. and PSW Berkeley.

APPENDIX 1
VASCULAR PLANTS DETECTED IN THE
CLARK FORK CANDIDATE RNA
AUGUST 21-24, 1989

This list includes all species noted during the four day survey. Taxonomy follows Munz (1968).
The following abbreviations are for habitat types:
wf.....white fir forest
rf.....red fir forest
ma.....mountain alder and montane riparian scrub
mcf.....mixed conifer phase of white fir forest
mh.....mountain hemlock dominated forest
wwp.....western white pine
wbp.....whitebark pine

Abies concolor : dominant in forest from ca. 6000-6900 ft.
Abies magnifica : common and dominant ca 7000-8500 ft.
Acer glabrum var. *torreyi* : common granitic outcrops in semi shade of wf, rf also edges of ma
Achillea millefolium : occas. throughout up to subalpine
Aconitum columbianum : occas. ma
Actaea rubra ssp. *arguta* : occas ma, lower elevs.
Adenocaulon bicolor : moist wf, mcf
Agastache urticifolia : occas rocky wf, mc, edges of ma
Agoseris glauca : edges of mds, ca 9600 ft. w/ lodgepole pine etc. an e-slope species
Agrostis scabra : occas edges ma, streamsides
Allium campanulatum : mc and open wf
Allium validum : common in subalpine mdws 9000 ft
Alnus tenuifolia : dominant along steep rivulets and seeps below 9000 ft.
Amelanchier pallida : occas. rocky wf, mcf, near streamsides ma
Anaphalis margaretacea : common along rivulets low to mid elevs, flowering
Anemone drummondii : past flowering, occas in gravelly openings upper elevs on volcanics 8800-9200 ft.
Angelica lineariloba : >8800 ft. on volcanic gravelly openings ± n-facing
Antennaria alpina : occas upper elev. meadow edges
Antennaria rosea : dryish openings mcf, wf, low-mid elevs.
Apocynum pumilum : mc, xeric wf, mcf
Aquilegia formosa : along streams, moist wf forest, ma
Arabis holboellii var. *retrofracta* : occas in open forests throughout
Arabis platysperma : mc granitic outcrops, narrower pods on volcanics up to 9400 ft. (different taxon than following?)

Arabis platysperma : occas granitic openings in wf, rf
Arceuthobium campylopodium : occas on wf, jp
Arctostaphylos nevadensis : common, mc, openings in wf, rf, mcf
Arenaria kingii : granitic openings, mc
Arnica amplexicaulis : uncommon along e boundary stream ca 7300 ft., 5-7 prs of leaves
Arnica cordifolia : semi-shade of mh 9300 ft.
Arnica discoidea : occas lower elevs wf, near streamsides
Arnica diversifolia : uncommon along e boundary stream
Arnica mollis : high meadow edges 9400 ft.
Artemisia douglasiana : occas. along streams low-mid elevs.
Artemisia ludoviciana ssp. *incompta* : streams and moist areas up to 9500 ft.
Artemisia arbuscula : occas upper elevs on volcanics open slopes
Artemisia rothrockii : meadow edge 9400 ft. w/ lodgepole pines
Aster foliaceus var. *parryi* : mdw at high elev similar to A. occidentalis but has pubescent phyllaries
Aster occidentalis : occasional upper elev meadows and streamsides
Astragalus lentiginosus var. *ineptus* : uncommon ca 9600 ft. in rocks type locality at Sonora Pass
Athyrium felix-femina : common ma, shaded streamsides
Brodiaea hyacinthina : occas vernally moist openings wf mcf
Bromus laevipes : occas. ± shaded forest wf, rf and along streams w/ ma
Bromus richardsonii : common in openings wf, rf, mcf
Bromus rubens : occasional even up to 9200 ft in open areas
Calamagrostis canadensis : common tall grass along flowing rivulets and streams
Calocedrus decurrens : common in mcf and wf lower elevs.
Calochortus leichtlinii : occas. mc, open rf mid-elevs
Cardamine breweri : common along flowing streams and rivulets 6000-9000 ft.
Carex abrupta : subalpine meadow edge ca 9400 ft.
Carex amplectens : moist areas mid-upper elevs. not in meadows?
Carex fracta : moist streamsides
Carex gymnoclada : along lower stream ma up to wet subalpine mdws. 9200 ft.
Carex hoodii : occas. moist slopes forest openings wf, mcf
Carex illota : wet subalpine mdw. 9200 ft.
Carex jonesii : occas along streams lower elevs.
Carex nebrascensis : wet stream sites ma,
Castilleja applegatei : occas mc, open wf, rf, mcf
Castilleja breweri : open slopes adjacent to subalpine mdws. or wbp ca. 9500 ft.
Castilleja miniata : fairly common along creeks ma, etc.
Ceanothus cordulatus : common mc and openings in wf, mcf
Chaenactis douglasii : occas. opening sin wf, mcf lower elevs.

Chimaphila menziesii : occas shady wf, mcf, rf
Cheilanthes gracillima : occas ro, granitics
Chenopodium sp. : uncommon openings in wf, mcf
Chrysolepis sempervirens : occas. mc seral wf, mcf
Chrysopsis breweri : fairly common throughout forested area most common in partially open areas
Chrysothamnus nausiosus ssp. *albicaulis* : occas. upper elev rf open granitic slopes
Circaea alpina var. *pacifica* : common shade of ma, streamsides
Cirsium andersonii : openings in wf, rf, mcf, up to mh
Cirsium vulgare : openings wf low elevs
Collomia tinctoria : common in openings in wf, mcf, rf
Corallorhiza maculata : occas wf, rf
Cornus stolonifera : occas. along permanent rivulets and streams
Crepis acuminata : uncommon at higher elevs., volcanics 8600-9200 ft. open forests and slopes
Cryptantha crymophila : uncommon on volcanics in rocky openings, ridgetops up to 9500 ft. endemic to Tuolumne and Alpine Cos.
Cryptantha simulans : openings in mc
Cryptantha torreyana : occasional in openings in wf, mcf
Cystopteris fragilis : occas wet streamsides, ma, crevices
Delphinium glauca : occas ma, west streambanks
Deschampsia caespitosa : occas. ma
Deschampsia elongata : ma , moist rivulets
Descurania richardsonii : occas open moist to rocky meadows adj to ma mid-elevs.
Dicentra uniflora : occas upper elev gravelly volcanic slopes
Dodecatheon alpinum : wet and moist subalpine mdws 9200-9500 ft.
Heleocharis sp.: tiny annual in moist muddy creek bank low elevs
Elymus glaucus : fairly common lower to mid elevs openings wf, mcf, rf
Epilobium angustifolium : occas along creeks mid elevs
Epilobium brevistylum : common along rivulets and in subalpine meadows
Epilobium glaberrimum : less common, with above
Epilobium hornemannii : subalpine mdw ca. 9000 ft.
Erigeron barbellatus : fairly common at high elevs> 9400 ft. type locality Silver Lake
Erigeron breweri : common throughout up to 9000 ft., open forests, mc
Erigeron compositus : highest elevs., 9600-9836 ft. dry rocky slopes
Erigeron coulteri : occas. along streams
Erigeron inornatus :? rf-wwp forest 8400 ft. above listed range is this ssp. *viscidulus* or another taxon?
Eriogonum marifolium : occas. granitic soils mc, rock outcrops
Eriogonum nudum : common openings in wf, mcf, rf, mc

Eriogonum ovalifolium var. *nivale* : occas. on high open ridges > 9400 ft.
Eriogonum umbellatum ssp. *stellatum* : occas. granitic mc <7500 ft.
Eriogonum wrightii var. *subscaposum* : >9200 ft. volcanic outcrops and ridges
Eriophyllum lanatum var. *monoense* : dwarfed w/ few stems this year infrequent mostly on volcanics of high elevs. 8200-9200 ft. open gravelly soil
Erysimum capitatum : occas wf, mcf
Eupatorium occidentale : occas volcanics upper elevs w/ rocky areas mh, etc.
Galium aparine : occas ma, mesic wf
Galium triflorum : common ma, shady streamsides
Gayophytum diffusum ssp. *parviflorum* : common in openings in wf, mcf, rf
Gentiana calycosa : Explorer's gentian, fairly common along rivulets moist areas and alder runs low to upper elevs.
Geum canescens : high elevs on volcanics dry open slopes ca 9500 ft. an e-slope species
Geum macrophyllum : streamsides, ma
Gilia leptalea : common annual in wf, mcf forest openings
Gilia leptalea ssp. *bicolor* : dry meadows and mdw borders up to 9500 ft.
Glyceria striata : common along streams low-mid elevs, ma
Goodyera oblongifolia : fairly common in shade of wf, mcf
Hackelia jessicae : occasional in openings in wf, mcf, rf
Hackelia mundula : long 5 mm spines covering nutlets velvety leaves, near n range limit, openings in wf
Haplopappus acaulis : fairly common dry exposed upper volcanic slopes 9400-9800 ft. an e-side taxon
Haplopappus bloomeri ?: similar to this taxon but with indistinctly graduated phyllaries, volcanic ridge ca 9400 ft.
Haplopappus macronema : occasional >9000 ft on volcanics open slopes
Haplopappus suffruticosus : fairly common on volcanics at high elevs.
Haplopappus whitneyi : serrate-leaved perennial herb with few narrow ray flowers, open rf, wwp, upper wf ca. 8000-9000 ft.
Helenium hoopesii : moist streamsides, occas up to 9300 ft in meadows
Heracleum lanatum : common ma
Heuchera rubescens : fairly common in shady areas among rocks low to high elevs.
Hieracium albiflorum : common wf, mcf
Hieracium horridum : rocky rf, mc
Holodiscus boursieri : rocky steep slopes wf, rf
Horkelia fusca ssp. *parviflora* : occas. dry flats low elevs in wf, mcf
Ipomopsis aggregata : occas granitic openings in mc mid-elevs
Ivesia lycopodioides : occas decomposed granitic soil upper elev rf ca 8500 ft
Juncus nevadensis : ma lower elevs.
Juncus parryi : rocky granitic slopes mid-upper elevs mc, ro

Juniperus occidentalis ssp. *australis* : open granitic slopes mc, occas subalpine on volcanics 6800-9300 ft
Kelloggia galioides : common wf, mcf
Leptodactylon pungens : occas. granitic soils of mc, rocky areas
Lilium kelleyanum: common ma, wet streamsides low-mid elevs.
Linanthus ciliatus : occas. granitic soils in mc, etc.
Linum lewisii : occas. upper elevs open volcanic slopes
Lomatium nevadense: occasional upper elevs, volcanic open slopes 9200-9500 ft.
Lupinus adsurgens: occas. in patches mostly on volcanics 8800-9200 ft. e.g. openings in rf and mh
Lupinus andersonii : occas. ± glabrous upper leaves, forest openings mid-upper elevs.
Lupinus andersonii var. *apertus* : ± glabrous upper leaves slightly pubescent banner no cilia on keel, upper elevs openings in mh, rf, >8200 ft. (listed to 7900 ft.) a N Sierra endemic listed S to Alpine Co.
Lupinus meconanthus : silvery strigose w/ small narrow leaflets and small flrs. openings in mh a volcanic endemic? of C and N Sierra and Modoc Plateau
Lupinus polyphyllus : occas ma, wet streamsides up to subalpine mdws.
Melica aristida : common in small openings in wf, mcf
Melica bulbosa : upper elevs openings in rf, mh
Microsteris gracilis: occas openings in wf
Mimulus floribundus: occas wet streamsides
Mimulus guttatus: ma, wet streamsides, etc.
Mimulus lewisii : ma, streamsides
Mimulus primuloides var. *pilosellus* : occas subalpine mdws. 9400 ft.
Monardella odoratissima ssp. *pallida* : common mc, seral wf, up to subalpine on volcanics
Orthocarpus copelandii : fairly common in open dry gravelly meadows above 9200 ft. (not listed above 8500 ft.)
Osmorhiza chilensis : moist wf, mcf
Osmorhiza occidentalis : occas subalpine wbp 9500-9700 ft.
Pedicularis semibarbata : occas wf, mcf
Pellaea breweri : in rocks upper elevs.
Penstemon bridgesii : occas upper elevs on volcanics open slopes
Penstemon laetus : past flowering, openings in forests, mc
Penstemon newberryi : granitic rocks in wf, mc, rf
Perideridia parishii : occas. open flats in alluvial wf near Clark Fork
Phacelia frigida : occas. open volcanic slopes ca. 9500 ft.
Phacelia racemosa : scattered in wf, mcf openings
Phacelia ramosissima var. *valida* : occas open to rel closed wf
Phleum alpinum : uncommon subalpine mdws.

Phlox caespitosa ssp. *pulvinata* : densely matted species on gravelly volcanic summit r idge 9500-9800 ft., not listed below 10,000 ft and Tuolumne Co. is N limits
Pinus albicaulis : common above 9000 ft. on volcanics some krummholz
Pinus contorta ssp. *murrayana* : occas stands mesic subalpine areas ca. 9300-9500 ft. also a few along Clark Fork ca 6000 ft.
Pinus jeffreyi : common in wf and mcf low to mid elevs occas on volcanics up to 9200 ft.
Pinus lambertiana : fairly common wf, mcf low-mid elevs.
Pinus monticola : common sub-dominant 8000-9500 ft. occurs as low as 6300 ft. on n-facing wf forest
Pinus ponderosa : rare a few trees at lowest elevs near Clark Fork
Poa epilis : fairly common upper elevs on volcanics
Poa nervosa: occas. openings in wf mcf
Polemonium californicum: occas wf, rf
Polemonium pulcherrimum : uncommon highest elevs on volcanics 9700-9836 ft.
Polygonum minmum : openings in wf low elevs.
Polygonum spergulariaeforme : common in forest openings low-mid elevs.
Populus tremuloides : occas. along Clark Fork and lower creeks below 6200 ft.
Populus trichocarpa: occas. streamsides and Clark Fork
Potentilla glandulosa ssp. *nevadensis* : occas streamsides, ma etc.
Potentilla gracilis ssp. *nuttallii* : ocas. lower elev ma, streamsides
Prunus emarginata : occas. open seral wf, mc
Pteridium aquilinum var. *pubescens* : occas along streams lower elevs, shady wf
Pterospora andromedea: occas. wf, mcf
Pyrola picta ssp *dentata* : occas, wf, mcf
Quercus kelloggii : a few shrubby ones in seral wf low-mid elevs
Quercus vaccinifolia: common in mc and seral wf, rf
Ribes cereum : occas along streams and on open slopes at higher elevs.
Ribes montigenum : occas. open rocky area mid-upper elevs.
Ribes nevadense : common ma, streamsides
Ribes roezlii : common wf, mcf
Rubus parviflorus : occas. along shady stream and moist wf low elevs.
Rumex angiocarpus: occas. moist streambanks and meadows lower elevs
Sagina saginoides var. *hesperia* : shady streamsides
Salix ligulifolia : fairly common along streams
Salix lutea : occasional along streams
Salix orestera : common around subalpine meadow at base of Bald Mtn ca 8800-9200 ft.
Salix scouleriana : occas streamsides low-mid elevs
Sambucus caerulea : occas streamsides, ma
Sarcodes sanguinea: occas. wf, mcf
Saxifraga punctata ssp. *arguta* : fairly common along wet rocky streamsides

Sedum obtusatum : occas. rocks mostly granitics mid-upper elevations
Senecio canus : wooly butterweed, leaves ± like *Eriogonum nudum* , spatulate, often with *Cryptantha crymophila* on exposed ridges
Senecio integerrimus : occas. open wf, rf
Senecio serra : similar in habit and habitat (somewhat drier) to *S. triangularis* , but leaves tapering to base, fairly common along alder runs
Senecio triangularis: moist streams, ma, meadows
Sidalcea glauca : small openings in wf, mcf lower elevs.
Silene lemmonii : fairly common : wf mcf openings and semi-shade
Sitanion hystrix : openings wf, mc, up to subalpine
Smilacina racemosa var. *amplexicaulis* : occas. mesic wf, edge ma
Solidago californica: occas: mc
Sphenosciadium capitellatum: occas. subalpine mdws, ma
Stachys rigida : moist areas near Clark Fork
Stephanomeria lactucina: fairly common open wf. rf. 6000-8500 ft
Stipa columbiana : flats in wf, mcf lower elevs.
Stipa occidentalis : fairly common up to 9000 ft. openings in forest, granite and volcanics
Symphoricarpos acutus : occas lower elevs in wf near streams
Symphoricarpos vaccinioides : common upper elevs on volcanics mh
Thalictrum fendleri: occas streamsides, ma
Thelypodium flexuosum : occas. upper elevs on volcanic open slopes ca 9500 ft. not noted for central Sierra may be a range extension S of 70 miles or more, a volcanic endemic
Trisetum spicatum : low-mid elevs. along streams and moist openings in forest wf
Tsuga mertensiana : common above 8200 ft. to crest
Urtica holosericea: streamsides ma
Veratrum californicum: occas. subalpine meadows
Viola glabella : ma, streamsides
Viola purpurea : occas open to rel closed wf, mcf
Wyethia mollis : common on volcanics above 8500 ft. open slopes

APPENDIX 2
VERTEBRATES DETECTED IN THE
CLARK FORK CANDIDATE RNA
AUGUST 21-24, 1989

This list includes all species seen, heard, or sign of presence noted during eh four day survey. The spotted owl is listed based on prior sighting in the area. Abbreviations for habitats are the same as in appendix 1.

FISH

Rainbow trout (*Salmo gairdneri*): small individuals up to 7 inches long in lower reaches of creeks

BIRDS

Red-tailed hawk (*Buteo jamaicensis*): occasional seen several times throughout area

Goshawk (*Accipiter gentilis*): family of at least three seen daily in white fir zone of lower and mid-elevations, presumed breeding

Sharp-shinned hawk (*Accipiter striatus*): an individual seen pursuing flock of juncos in red fir forest on one day

Cooper's hawk (*Accipiter cooperi*): one, or more individuals seen in white fir to alpine zone on one day

Golden eagle (*Aquila chrysaetos*): seen in alpine area near summit of pk 9836.

Mountain quail (*Oreortyx pictus*): occasional mc

Blue grouse (*Dendragapus obscurus*): six individuals seen in mh at edge of wet meadow at 9200 ft.

Spotted owl (*Strix occidentalis*): a successful breeding pair monitored in and adjacent to RNA in 1989.

Northern flicker (*Colaptes auratus*): fairly common throughout up to summit of Pk. 9836 (where feeding on ants terrestrially)

Pileated woodpecker (*Dryocopus pileatus*): borings throughout older white fir, also heard in alluvial wf

White-headed woodpecker (*Picoides albogualris*): common in white fir forests

Hairy woodpecker (*Picoides villosus*): occasional white fir forest

Rufous hummingbird (*Selasphorus rufus*): seen at *Ipomopsis aggregata* mid elev. ro

Common nighthawk (*Chordeiles minor*): heard over campground one night

Violet-green swallow (*Tachycineta thalassina*): low elevations over wf

Western wood pewee (*Contopus sordidulus*): occas lower elevs in openings in wf, mcf

Olive-sided flycatcher (*Contopus borealis*): occasional wf, rf

Clark's nutcracker *(Nucifraga clarkii*): common from low elevations to highest summits

Steller's jay (*Cyanocitta stelleri*): widespread throughout forests to subalpine zone

Mountain chickadee (*Parus gambeli*): common in coniferous forest up to subalpine zone
Golden-crowned kinglet (*Regulus satrapa*): fairly common in fir forest of low to middle elevations
Townsend's solitare (*Myadestes townsendi*): occasional white fir and red fir forest
American robin (*Turdus migratorius*): fairly common lower elevations white fir forest
White-breasted nuthatch (*Sitta carolinensis*): occasional, white fir forest
Red-breasted nuthatch (*Sitta canadensis*): abundant wf, rf
Water ouzel (*Cinclus mexicanus*) along Clark Fork
Winter wren (*Troglodytes troglodytes*): along alder run sw corner of area
Brown creeper (*Certhia americana*): occasional wf and rf
Hermit thrush *(Catharus guttatus*): fairly common wf, rf, subalpine
Solitary vireo (*Vireo solitarius*): occas. wf, mcf
Hermit warbler (*Dendroica occidentalis*): occas. wf, rf
Yellow-rumped (Audubon's) warbler (*Dendroica coronata*): common wf, rf
Western tanager (*Piranga ludoviciana*): occasional white fir forest
Nashville warbler *(Vermivora ruficapilla*): occasional wf
Dark-eyed (Oregon) junco (*Junco hyemalis*): common wf, mcf
Pine siskin (*Carduelus pinus*): flocks occasional throughout

MAMMALS
Alpine chipmunk (*Tamias alpinus*): krummholz whitebark pine
Long-eared chipmunk (*Tamias quadramaculatus*): common in mixed conifer phase of wf and open wf up to rf
Lodgepole chipmunk (*Tamias speciosus*): at high elevations in rf and subalpine forests
Beechey ground squirrel (*Spermophilus beecheyi*): occas, openings lower elvs.
Golden-mantled ground squirrel (*Spermophilus lateralis*): occasional throughout
Mountain pocket gopher (*Thomomys monticola*): common in openings low elevations up to summits
Deer mouse (*Peromyscus maniculatus*): common at lower elevations (several seen around campground)
Pika (*Ochotona princeps*): talus at upper elevations
Mule deer (*Odocoileus hemionus*): fairly common throughout area
Douglas squirrel (*Tamiasciurus douglasii*): very common in white fir forest
Black bear (*Ursus americanus*): tracks and other sign seen low and mid-elevations

Photo Captions for Clark Fork Ecological Survey

Photo 1: Eroded volcanic tuff cliffs at upper elevations, ne 1/4 sec. 9, ca. 9000 ft.

Photo 2: Effect of avalanches on nw-facing slope (with red fir as potential climax species). Note scattered montane chaparral shrubs where avalanche recently occurred adjacent to red fir forest with relatively high mortality from drought-related insect attack.

Photo 3: Alluvial phase of white fir forest with relictual Jeffrey pine ca. 4 ft. dbh left foreground. Note high density of mid-sized and large white fir and level terrain.

Photo 4: Dead skeletons of mountain chaparral shrubs in understory of young (ca. 80 year old) white fir stand, sw 1/4 sw 1/4 sec. 5.

Photo 5: Large fire-singed white fir (ca. 6 ft. dbh) in transitional forest ne1/4, sw 1/4 sec. 5.

Photo 6: Large (ca. 80 inch dbh), old incense-cedar in transitional white fir forest se 1/4, sw 1/4 sec. 5.

Photo 7: Old growth white fir forest at base of steepening slope ne 1/4 sw1/4 sec. 5. Note sparse understory and low white fir reproduction.

Photo 8: Steep north slope white fir forest nw 1/4 sec. 4 ca. 6800 ft. Note relatively open canopy and scattered reproduction.

Photo 9: Understory of west-facing mixed conifer phase of white fir forest with local canopy dominance by Jeffrey pine and dense understory of *Arctostaphylos nevadensis* and *Quercus vaccinifolia*.

Photo 10: Successional white fir phase on wnw-facing slope ca. 6900 ft., ne 1/4 sec. 8. Note rocky patch of *Quercus vaccinifolia* -dominated montane chaparral surrounded by even-aged 80-year-old white fir.

Photo 11: Open red fir forest with significant western white pine component on ne-facing slope, ca. 8300 ft. se 1/4 sec. 4.

Photo 12: Grove of western white pine on very rocky granitic ridgetop within upper elevation red fir zone ca. 8500 ft. ne 1/4 sec 9.

Photo 13: Steep northern face of Bald Peak showing bedrock escarpment and colluvium composed primarily of reddish basalt. Mixed whitebark pine-mountain hemlock forest in foreground.

Photo 14: Successional phase of mixed montane chaparral resulting from regular avalanche scouring of drainage sw 1/4 sec. 3.

Photo 15: Mountain alder-dominated riparian scrub in avalanche chute se 1/4 sec. 8.

Photo 16: Wind-flagged stand of mixed whitebark pine and mountain hemlock on n-facing slope. allest stems are ca 30 ft. Elevation 9000 ft. ne 1/4 sec. 9.

Photo 17: Southwest-facing krummholz stand of whitebark pine ca. 9300 ft. sw 1/4 sec. 10.

Photo 18: Subalpine stand of lodgepole pine on gentle sw-facing slope adjacent to wet meadow in se 1/4, ne 1/4 sec. 9 elevation ca. 9120 ft.

Photo 19: Southwest-facing aspect of subalpine dry meadow habitat on basalt at ca. 9400 ft., sw 1/4 sec. 10.

Photo 20: Sparse subalpine steppe on wind-scoured volcanic tuff ridgetop ca. 9200 ft. se 1/4, ne 1/4 sec. 9.

Photo 21: Lush, wet subalpine meadow at head of drainage north of Bald Peak. Note whitish tuff deposit on lower right ridge.

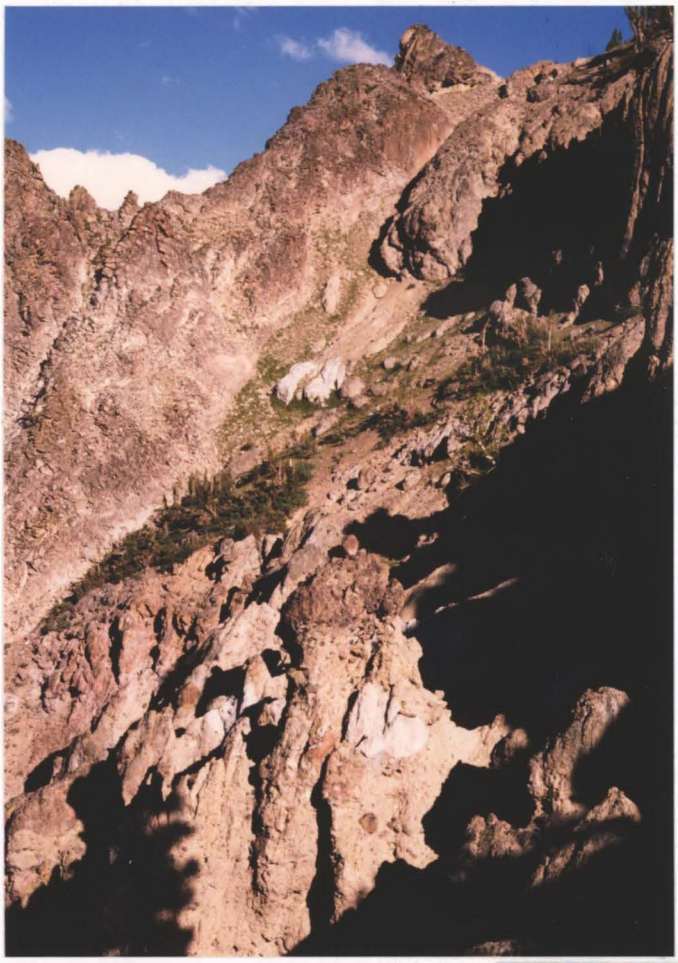


FIGURE 1

FIGURE 2

FIGURE 3

FIGURE 4

FIGURE 5

FIGURE 6

FIGURE 7

FIGURE 8

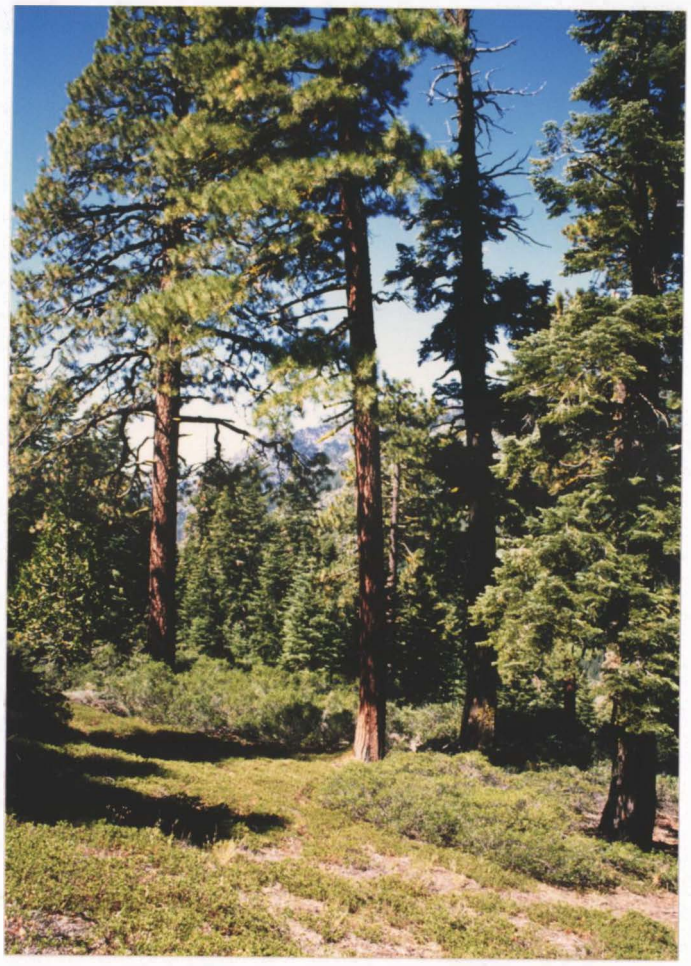


FIGURE 9

FIGURE 10

FIGURE 11

FIGURE 12

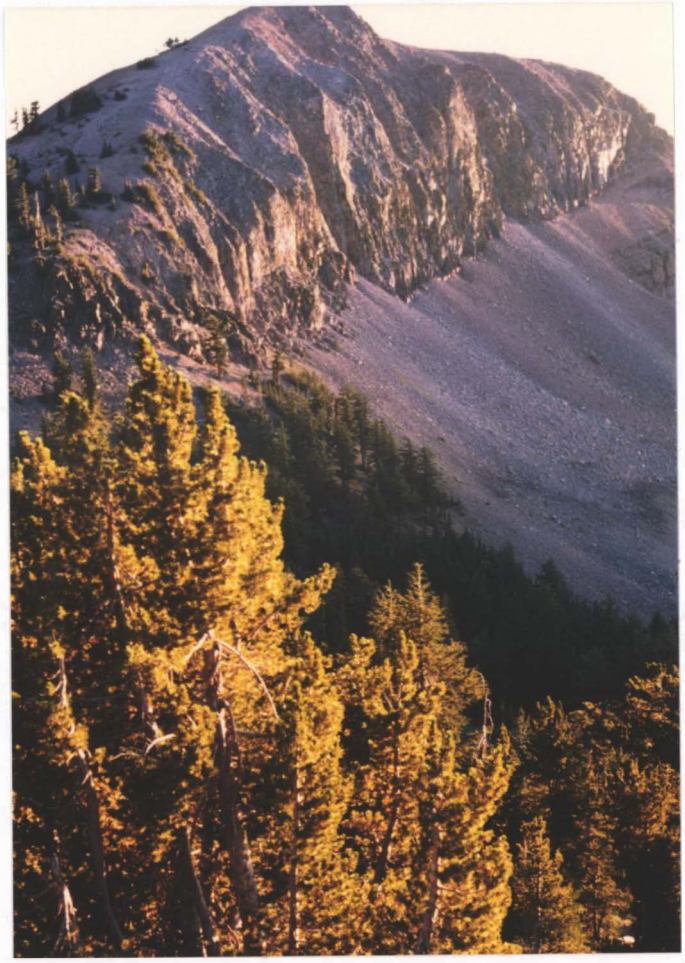


FIGURE 13

FIGURE 14

FIGURE 15

FIGURE 16

FIGURE 17

FIGURE 18

FIGURE 19

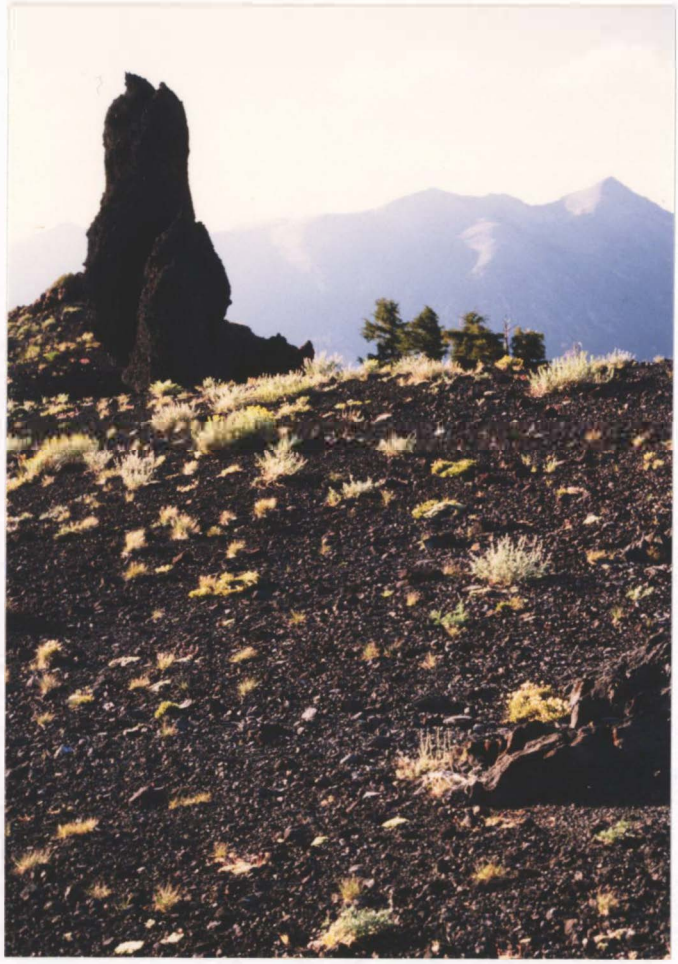


FIGURE 20

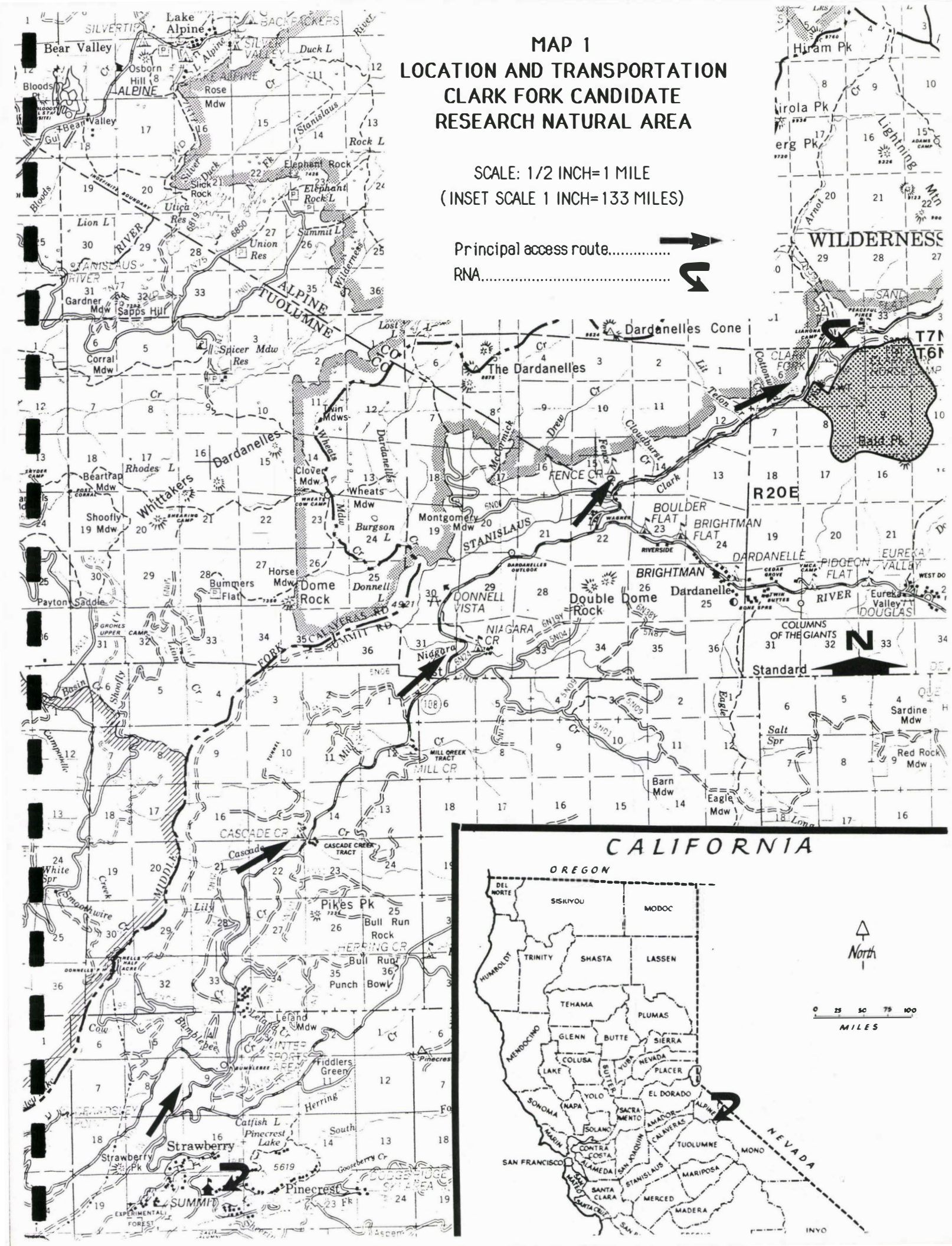
FIGURE 21

MAP 1
LOCATION AND TRANSPORTATION
CLARK FORK CANDIDATE
RESEARCH NATURAL AREA

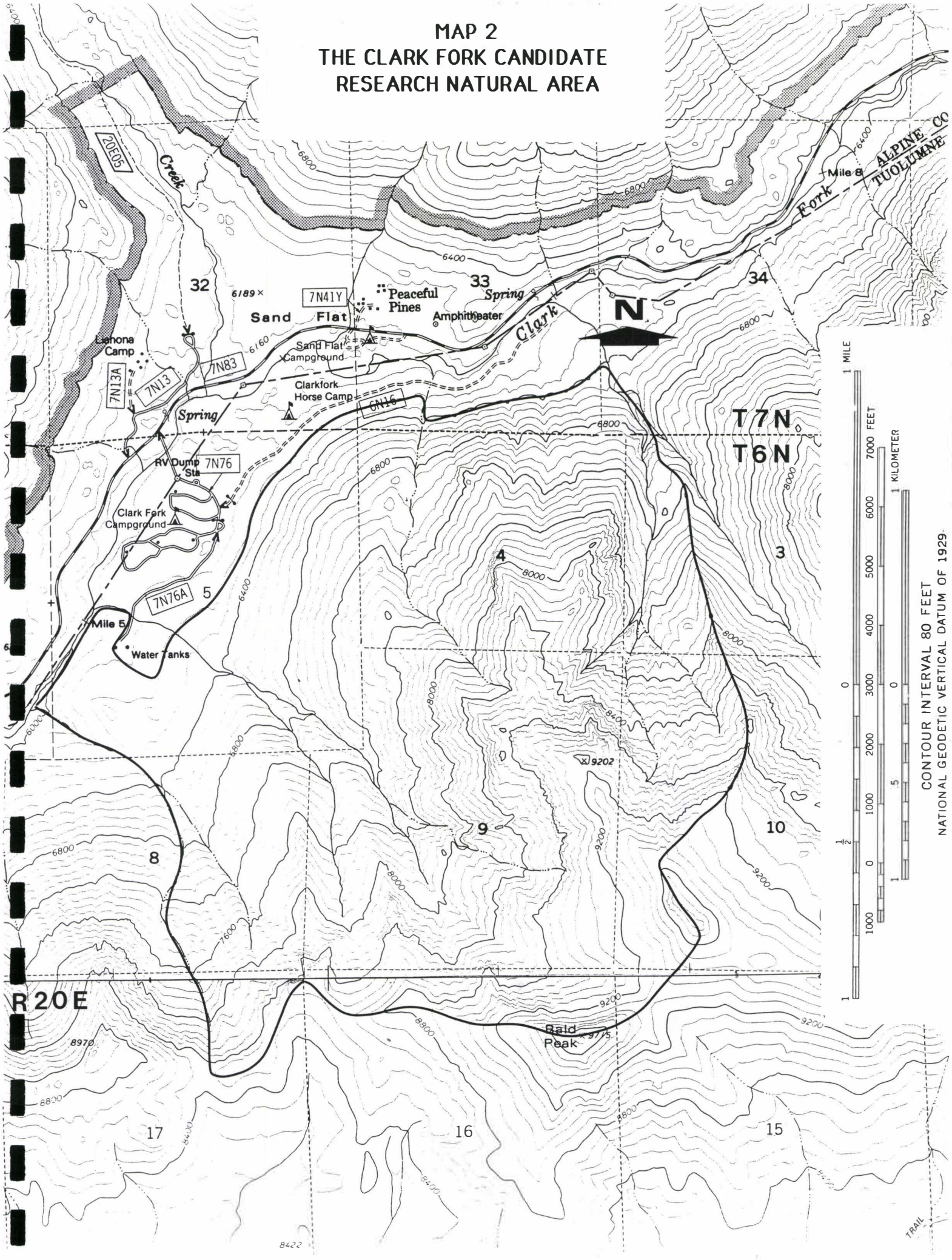
SCALE: 1/2 INCH=1 MILE
(INSET SCALE 1 INCH=133 MILES)

Principal access route.....

RNA.....



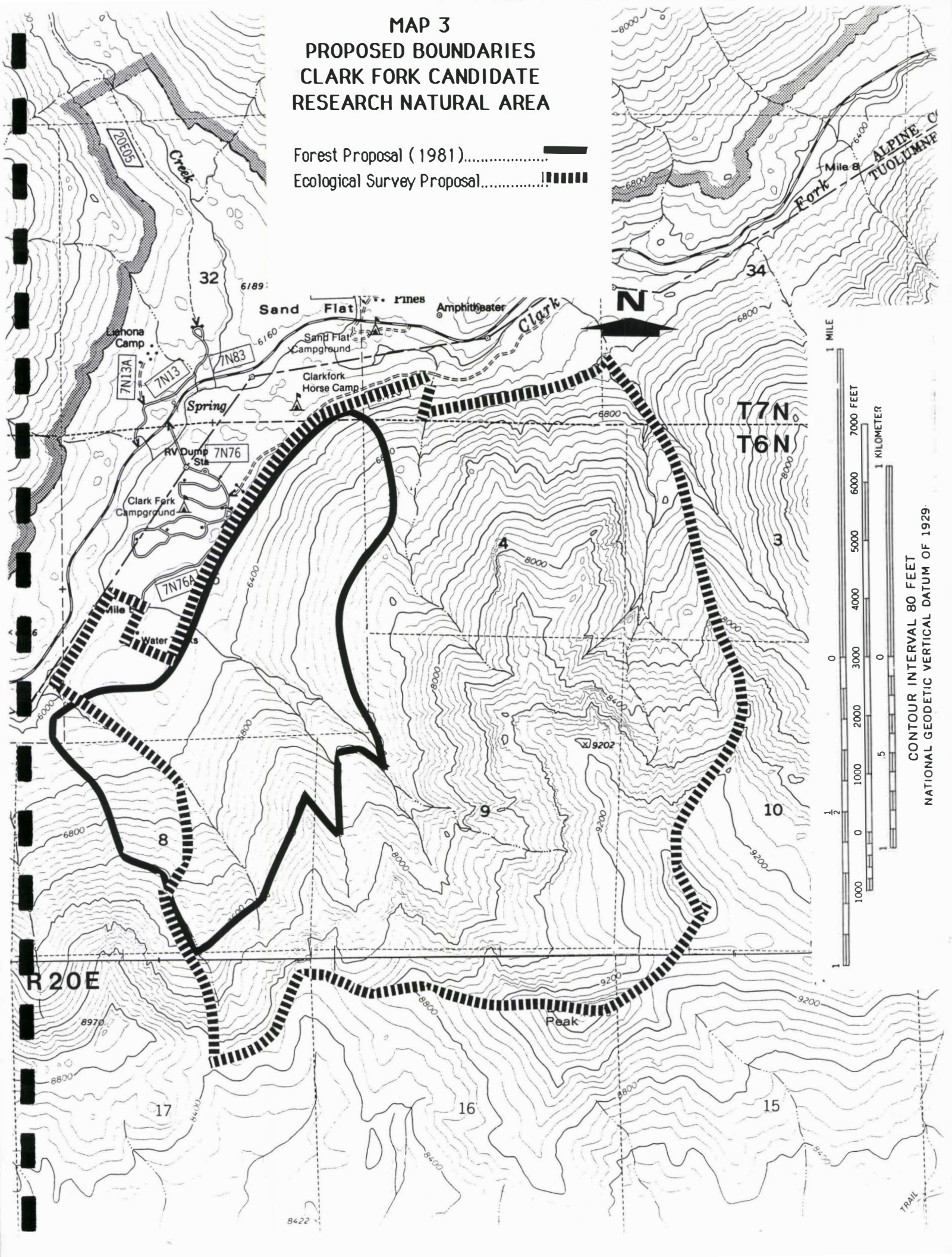
MAP 2
THE CLARK FORK CANDIDATE RESEARCH NATURAL AREA

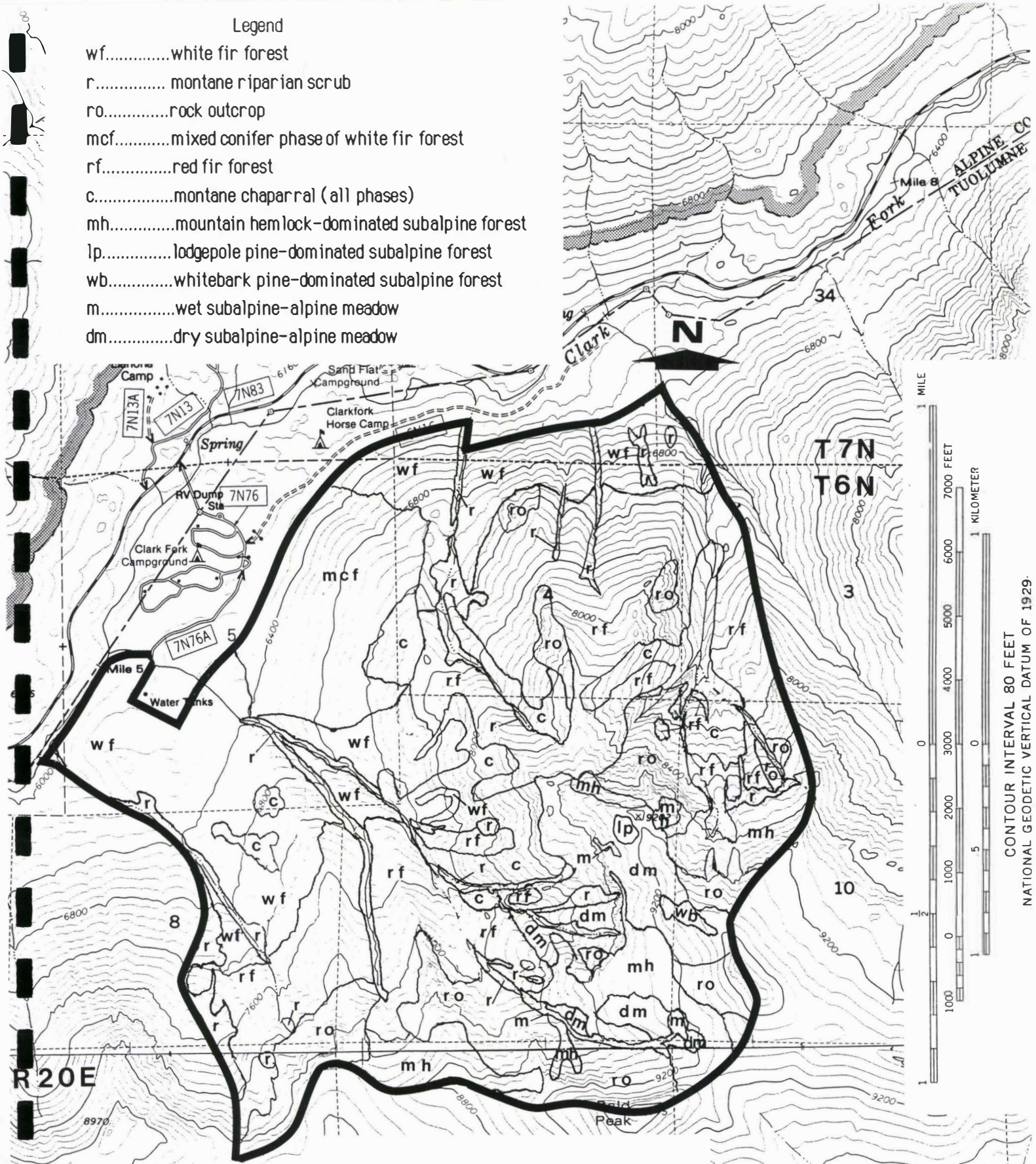


MAP 3
PROPOSED BOUNDARIES
CLARK FORK CANDIDATE
RESEARCH NATURAL AREA

Forest Proposal (1981).....

Ecological Survey Proposal.....

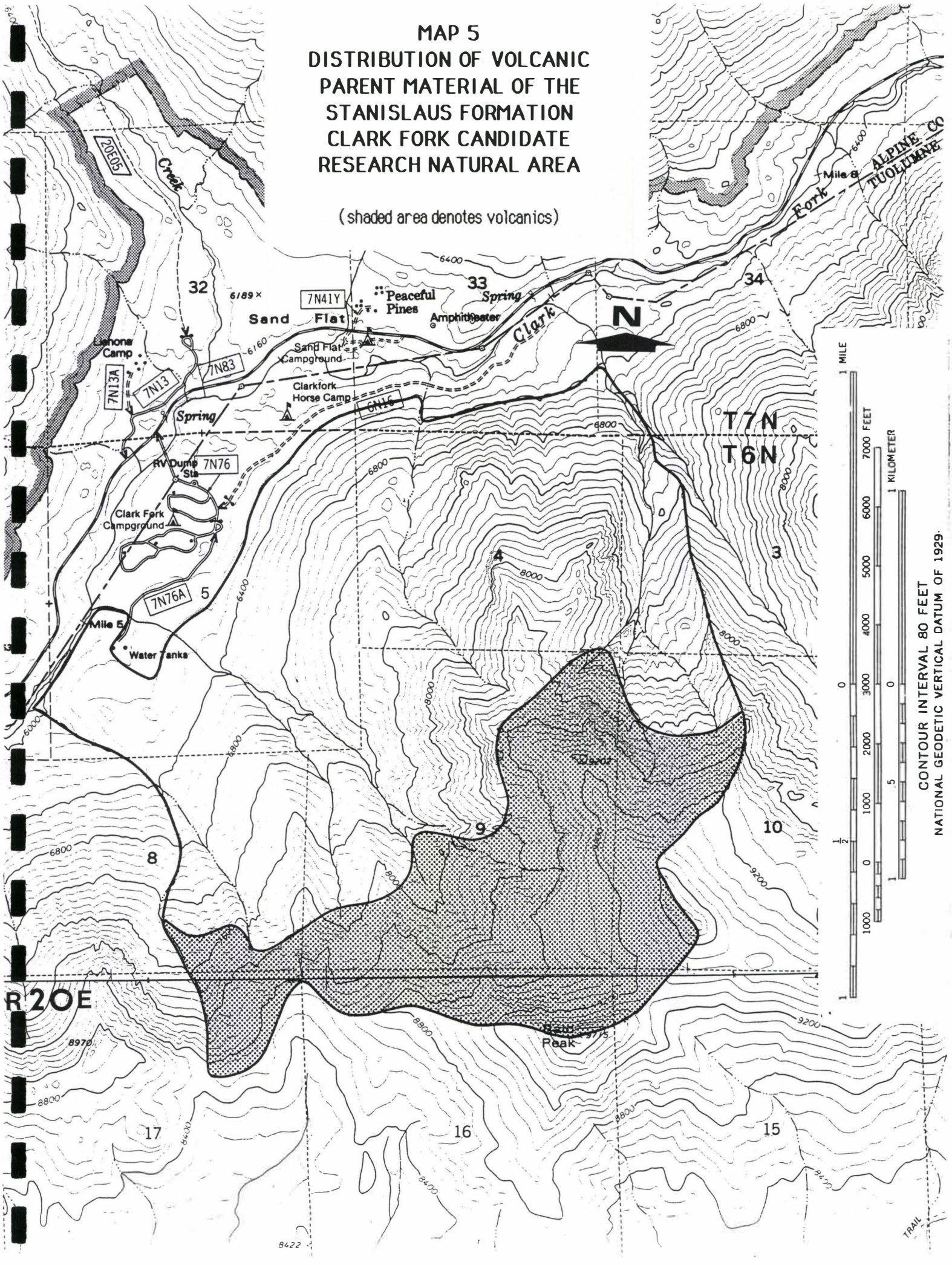


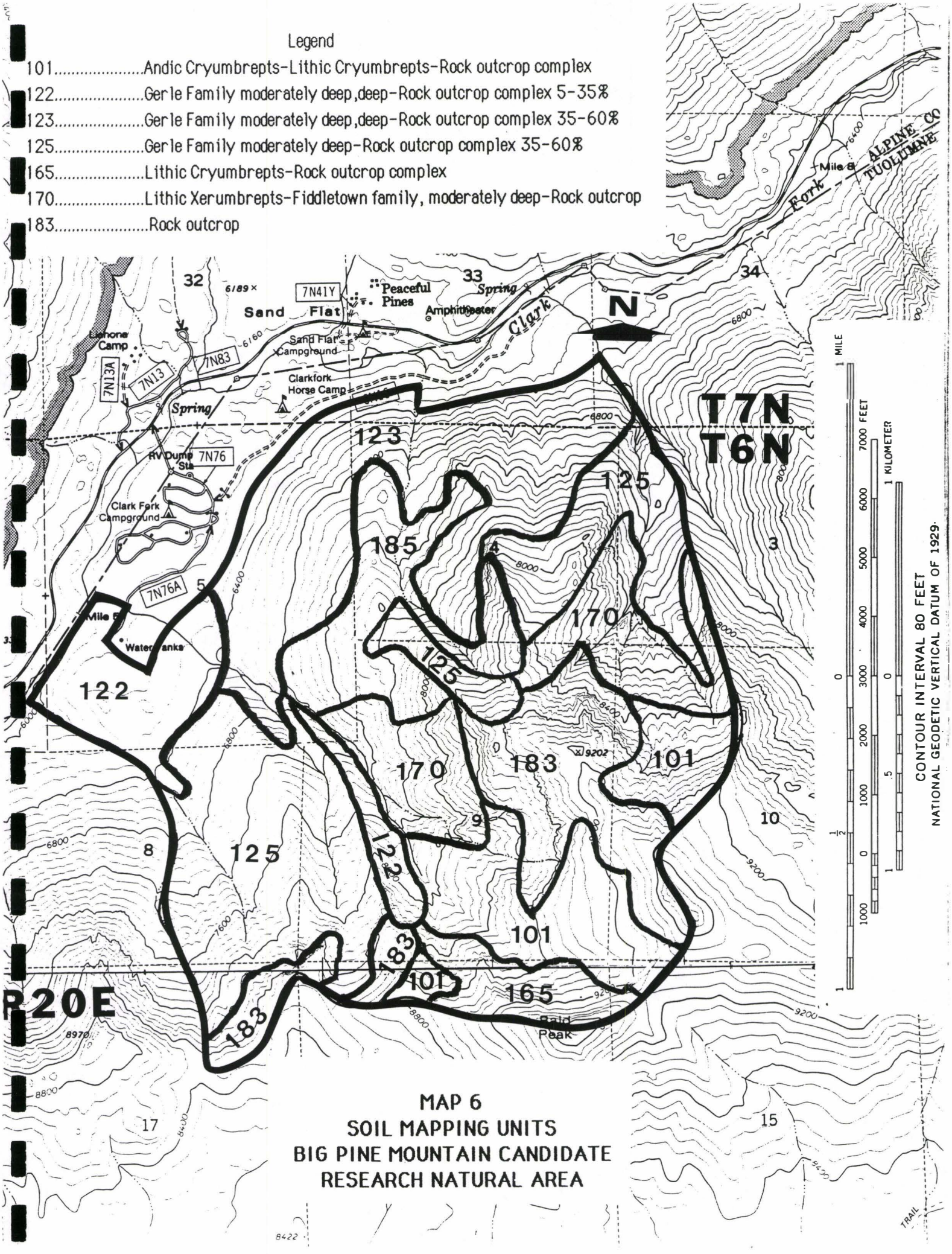


MAP 4
VEGETATION MAP
CLARK FORK CANDIDATE
RESEARCH NATURAL AREA

MAP 5
DISTRIBUTION OF VOLCANIC PARENT MATERIAL OF THE STANISLAUS FORMATION CLARK FORK CANDIDATE RESEARCH NATURAL AREA

(shaded area denotes volcanics)





MAP 6
SOIL MAPPING UNITS
BIG PINE MOUNTAIN CANDIDATE
RESEARCH NATURAL AREA